

THE EFFECT OF RESOURCE INVESTMENT PROGRAMS
ON LABOR EMPLOYMENT

By

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A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA
1973

ACKNOWLEDGEMENTS

The author wishes to express appreciation to the Food and Resource Economics Department, University of Florida, and the Economic Research Service and Soil Conservation Service, United States Department of Agriculture, for making this research possible. Sincere appreciation is acknowledged to Dr. B. R. Eddleman, Chairman of the Supervisory Committee, for his guidance and assistance during the author's graduate program. Gratitude is also expressed to Drs. J. E. Reynolds, K. C. Gibbs, and R. W. Bradbury who served as committee members. Dr. W. W. McPherson also provided valuable comments.

Mr. Gene Harris provided valuable programming assistance. Dr. Neil Cook, Economic Research Service, United States Department of Agriculture provided excellent comments and guidance.

The author also wishes to express thanks to Mrs. Christine Ward for her valuable assistance in typing the dissertation and to Mrs. Phyllis Childress for her clerical and typing assistance in earlier drafts. Appreciation is also due Miss Wanda Rhea who typed a complete draft of the dissertation.

The greatest debt is due the author's wife, Diane, and sons Kyle and Chad, for their unselfish devotion and sacrifice during his graduate program.

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Abstract of Dissertation Presented to the
Graduate Council of the University of Florida in Partial
Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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December, 1973

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Major Department: Food and Resource Economics

This study examined the importance of investments in human and natural resources along with several other variables in explaining employment changes among counties comprising the four-state region of Mississippi, Alabama, Georgia, and Florida over the time period 1960 to 1970. Counties in the study area were delineated into urban and nonurban counties according to their human and natural resource endowments. A theoretical economic model was developed that explains changes in employment and firm numbers brought about by exogenous shifts in the supplies of resources, demand for products, supplies of other factors, firm production possibilities, and shifters of the number of firms in an industry.

Empirical analysis was undertaken to determine the importance of each exogenous shifter on industry employment changes. The industries studied included agriculture, construction, textile mill products and other fabricated textile products, food and kindred products, transportation, furniture and fixtures, lumber and wood products, electrical equipment, durable, and nondurable products manufacturing. Changes in factor supplies included changes in per pupil

education expenditures, Corps of Engineers investments, Soil Conservation Service investments in the Public Law 566 Small Watershed Program, Agricultural Stabilization and Conservation Service payments in the Agricultural Conservation Program and loans and grants for community water and sewer systems made by the Farmers Home Administration. Changes in county product price indexes, allotment reductions, farm operator age, wage rates, technology indexes, number of firms, and alternative wage and employment opportunities represented the other types of exogenous shifters.

General equations for empirical analysis were specified for each industry. A two-equation model was used for agriculture with the number of farms considered endogenous. Single equation models were specified for the remaining industries. Changes in the number of firms were considered exogenous in these models. Two-stage and ordinary least squares were used as empirical estimation procedures.

Results indicate that employment changes emanating from changes in the exogenous shifters differed quite substantially among industries and the county groups considered. Most employment effects were generally consistent with expectations. Logical explanations were normally apparent for employment effects that differed from initial expectations. It was observed that some investments influenced employment in a particular industry and yet were not important in other industries. Location of industries was also important. Effects differed between the urban and nonurban counties for some industries. The most satisfactory results were obtained for agricultural employment and farm number changes.

Results indicated that any attempt to stimulate employment in an area with investments in human and natural resource should take into consideration not only the agricultural, urban, and nonurban characteristics of the area, but the type of industry employment most evident in the area.

CHAPTER I

INTRODUCTION

Investments in natural resources usually are for the expressed purposes of conserving, developing, or managing the nation's supply of soil, water, timber, mineral, and marine resources. Many public investment programs in natural resources such as those associated with the Tennessee Valley Authority (TVA) and the Small Watershed Development Program¹ administered by the USDA's Soil Conservation Service contained explicit development objectives. These objectives were concerned with alleviating depressed regional economic conditions or improving the incomes of specific groups of people.

Senate Document 97 [1], issued in 1962, also made explicit a national policy of natural resource investments for purposes of increasing income and employment in particular regions. The Appalachian Regional Development Act of 1965 [2] provided for the construction of water resource projects to stimulate economic growth of the region. Guidelines concerning principles and standards for the planning of water and related land resource use, issued for review by the Water Resources Council [3] in 1971, gave added emphasis to the role of water

¹This program, created by the Watershed Protection and Flood Prevention Act of 1954, with its Amendments, is commonly referred to as Public Law 566.

resource investments in the development of a regional economy. This orientation in policy has given added emphasis to natural resource development programs and projects as instruments for dealing with regional economic problems. Many other programs have evolved that focus on goals of community improvement by concentrating on such areas as increasing local employment and income, increasing public revenues, and improving the quality of the environment.

Local employment and income of an area depend on many factors other than investments in natural resources. Any explanation of employment and income changes occurring within a region requires analysis of the many variables which interact to determine these changes. Identification and measurement of these complicated interdependencies are necessary in order to assess previous or prospective effects of the various programs in influencing the level of employment and income. Changes in investment levels that shift the supplies of critical resources often occur concurrently with changes in the demands for products, supplies of other resources, firm production possibilities, and the number of firms. An important element is the consideration of how equilibration in product and factor markets is affected by programs designed to change the supplies of resources and, in turn, how changes in product and factor prices affect the level of output, resource employment and income within the recipient region. Since similar investments in heterogenous regions might have different effects on employment, dissimilarities among regions need to be considered. These differences could exist in the form of differing resource base or differing industrial structure.

Planners and decision-makers need information on the effectiveness of the small watershed and other natural resource projects in

fostering employment and income growth. Knowledge concerning the relationships between natural resource investment and the other important stimuli on changes in employment and income in a regional economy is vital. Back [4] has pointed out that assessment of the role of natural resource investments in stimulating growth of a regional economy will be a difficult task without information of this type.

Competition for the federal dollar between supporters of various programs is very keen. Areas faced with employment and income problems should utilize scarce resources in programs that would result in the greatest rates of change in employment and income. Thus, information on the effectiveness of natural resource investment programs in meeting specified objectives is critical for future program planning. The results of this evaluation will indicate that either small watershed and other natural resource projects satisfy income and employment objectives or that program reform is necessary if objectives continue to include income and employment goals. This research, though conducted for a sub-region of the Southeast, should provide answers applicable to the entire Southeastern region. It is sufficiently broad to be indicative of the national Small Watershed Program and other resource development programs.

Objectives

The general objective of this study is to evaluate the effectiveness of the Small Watershed Program and other natural resource investments in accelerating employment growth in local recipient areas. The study includes the four-state region of Mississippi, Alabama, Georgia,

and Florida over the time period 1960 to 1970. More specifically, the objectives are to:

1. Develop an economic model to explain changes in employment and in the number of firms brought about by exogenous shifts in the supplies of resources, demand for products, supplies of other factors, firm production possibilities, and shifters of the number of firms in an industry.
2. Empirically apply the model to selected industries in order to determine the importance of changes in the above factors on changes in employment and in the number of farm firms.

Review of Literature

Previous studies concerned with the estimation and explanation of the effects of investments in natural resources on employment, income, and output are quite varied in purpose, objective and scope. All previous work can be grouped into three basic categories consisting of (1) case studies of individual projects and their impacts on local areas, (2) studies proposing various procedures that could be used in evaluating project effects, and (3) studies that attempt to determine the effect of water resource investments over large multi-county or multi-state areas. Some of these studies are reviewed in this section to provide a cross section of previous work.

The first group consists of case studies of various small watershed projects and the impact of the investment program on the local economy and/or the sectors they were intended to benefit. Jansma and Back [5] estimated the local secondary effects of the construction

of watershed project structures for upstream flood protection in Roger Mills County, Oklahoma. Through the use of an input-output analysis they estimated income multipliers which were used to determine the effect on the county's economy of increases in agricultural and recreational income as a result of the watershed program. They found that for each \$100,000 in gross receipts to farmers in the county, there was an estimated net (disposable) income to farmers of \$26,867. This \$100,000 increase also generated \$77,845 in gross receipts to other sectors of the local economy and a net income of \$16,457 to these sectors. The local gross receipts multiplier of farm income was 1.78 and the local net income multiplier was 1.62. Net income receipts from gross recreational receipts were about one-half those of gross agricultural receipts. Gray and Trock [6] in an evaluation of the Green Creek Watershed Project in Texas used traditional benefit-cost analysis to compare the actual benefit-cost ratio derived from post-project evaluation with the ratio estimated in the watershed work plan. They found that the project failed to provide benefits in excess of costs over the first eight years of the project. The ratio of benefits to costs determined by the study was .919:1 as compared with an estimate of 1.49:1 made in the watershed work plan.

Input-output analysis was used by Kasal [7] to estimate the local economic impacts in a four-county area as a result of five Colorado watershed projects. Local net income arising from project expenditures as well as benefits to the project users were estimated. Kasal compared the original benefit-cost ratios for the projects with those derived through the use of multipliers from the input-output

analysis and found that the local economic impact of all five projects exceeded that estimated in the watershed work plan. Clonts² is using a similar analysis to measure the economic impact of the Cheaha Creek Watershed on the local economy of Talledega County, Alabama. Cato and Eddleman³ are evaluating the secondary impacts from the Taylor Creek Watershed Project in a six-county area of South Florida. Work in this study has been directed toward estimating the net increases between the local impact area and the rest of the U. S., and among groups within the local area. Several other studies not mentioned were concerned mainly with benefits to primary project users, land use, and increases in farmland values.

The second category of studies has been concerned primarily with the introduction of suggested methodology for use in the evaluation of water resource investments. The first of these methods as suggested by Eidman [8] has had one empirical application. Eidman's presentation described the linkages or interdependence of the various sectors and subsectors of Southwestern Oklahoma with the use of a simple five-equation economic model that employed economic base multipliers and regression multipliers. This model was designed to explain employment and income changes as a result of resource investments. Mazuera [9] used the model to determine the secondary impact of using water in the Sugar Creek Watershed floodwater prevention structures for irrigation development and found that the project generated secondary effects amounting to

²H. R. Clonts, personal communication.

³Work currently in progress.

less than a 1 percent change in both population and total income in the watershed project area.

The work of Bromley et al. [10] attempts to outline the role of economic logic and method in analyzing the consequences of water resource investments. Their work does not offer a concrete method of project evaluation but rather is concerned with the many questions raised in such an undertaking. A later study by Gibbs and Loehman [11] deals with the evaluation of resource investment projects in terms of multiple public goals. This study offers a model that might be used to predict regional economic effects of resource investments which the authors claim presents a more realistic view of the regional economy than input-output or multiplier analysis.

The last category of studies has also been concerned with the estimation of the impacts of water resource development at the local level, but includes studies concerned with a much broader geographical area than the local project area. Many of these studies used county observations in various forms of econometric models to examine resource investment effects while others examined regional differences in the effects of resource investments. Haveman and Krutilla [12] looked at both the national and regional effects of twelve types of water resource projects with respect to their influence on various occupational and industrial categories. Their analysis based on input-output models constituted an effort to sort out the demands which public expenditures for water resource developments imposed on the economy.

Water availability in relation to regional economic growth was assessed by Howe [13] who determined that water deficit areas did not experience drawbacks to economic growth and that water surplus areas

were not guaranteed rapid growth. Howe's study suggested that water resource developments are likely to be poor tools for accelerating regional economic growth if markets, resources, and other factors considered vital to development are lacking. Howe did not consider the effect of water resource development on small regions.

Wiebe[14] attempted to evaluate the effectiveness of water resource investment projects in alleviating regionally depressed economic conditions. This study of the Tennessee River Watershed consisting of 125 counties in parts of seven states suggested that (1) residents in counties close to water resource investment projects enjoyed a greater per capita income in the long run than did those living farther away, (2) investments in water resources were in the long run associated with increases in employment in counties removed from the project site while nearer counties were associated with long run decreases in employment, and (3) investments were not associated with an increase in the level of living for people in low income and less educated groups living near investment areas as compared to similar groups living in areas removed from the investment site.

Another analysis by Cox et al. [15] was specifically designed to assess broad based economic growth emanating from multipurpose projects by the application of multiple regression analyses to many socioeconomic indicators. Counties in the 13 Northeastern states of the United States in which large water resource development projects had been constructed between 1948 and 1958 were examined in 1960 to determine if changes had occurred as a result of the projects. They concluded that there was no relationship between project size and economic growth and that the selection of project sites was biased toward urban areas where there is

a greater a priori likelihood of economic growth. They concluded that it was dubious whether water resource projects served as a stimulus to economic growth for the area studied. An index of economic growth based on numerous income and employment variables were used to measure economic growth.

Boxley and Harmon⁴ have recently worked on a study to determine the relationship between Public Law 566 watershed investments and economic growth in the Southeastern United States since 1959. Economic growth was measured as income changes. They have attempted to use a modified form of the shift-share analytical technique for the period 1959-1968. Tentative conclusions are that (1) there was no measurable relationship between watershed investment and economic growth, and (2) the selection of watershed sites for development appeared random when measured in terms of rates and types of economic growth underway in the study area. They have expressed limitations, however, as to the appropriateness of the statistical techniques used and thus offer these conclusions in a qualified manner. They do point out that other elements of capital infrastructure are probably necessary for economic growth to occur.

Cato and Eddleman⁵ are also concerned with the relation of changes in income over the last two decades to the level of investment in natural resources for the same time period. Counties of a nine-state region of the Southeastern United States have been delineated into four groups on the basis of their natural and human resource endowments

⁴Robert F. Boxley and Marie Harmon, personal communication.

⁵Work currently in progress.

and level of economic activity. Multiple regression and correlation analysis have been used to examine the effect of the level of natural resource investment on changes in various income measures for the four groups. The various types of water resource investments being considered that are of interest to this study include water projects of TVA, Corps of Engineers, and investments under the Small Watershed and Flood Prevention Watershed Programs of the Soil Conservation Service. Tentative results have indicated that with the exception of some investments by TVA and the Corps of Engineers, little effect is felt in local income changes as a result of these water development projects. Conflicting patterns have emerged as to the type of investment recipient area that realizes the greatest impact.

This survey of the literature concerning the effect of water resource investment on economic growth leads to two observations. Either water resource investments are poor tools for stimulating economic growth, or the methodology for measuring these effects falls far short of accomplishing the goal for which it was designed. Many of the studies cited have failed to consider the importance of interdependencies among other important factors within a region which affect employment and income changes. Changes in investment levels that shift the supplies of critical factors, i.e., investments in water resources, often occur concurrently with changes in the demands for products, supplies of other resources, firm production possibilities, and shifters of the supply of firms. Equilibration in product and factor markets is affected by programs designed to change the supplies and/or productivity of resources and this in turn causes changes in product and factor markets which affect the level of employment and income within the recipient region.

A general approach that could be used in considering these additional changes has been suggested by Tolley and Schrimper [16] and Schrimper [17]. This approach simultaneously considers aggregate and micro adjustments in product and factor markets. Application of a variant of the general model was performed by Schrimper [18] to determine the extent to which changes in various exogenous factors suggested by the general model explained changes in the number of farms between 1954 and 1959 for six comparable groups of farms among states as well as among counties within North Carolina and Illinois.

Eddleman and Cato [19] in a current study are using the same variant of the general model as Schrimper to examine factors affecting differential rates of change in the number of farms among counties in Florida for the time period 1959-1969. Eddleman [20] has also proposed the use of another variant of the general model to analyze the effects of investments in resource development programs on regional employment.

CHAPTER II

THEORETICAL FRAMEWORK

All previous work using variants of the general model developed by Tolley and Schrimper [16] has been concerned with measuring the rate of change in employment or farm numbers. That is, employment and farm number changes as well as changes in the exogenous variables were measured as percentage changes. The two-equation model developed in this study is concerned with explaining absolute changes. The first equation of the model explains changes in employment as a function of exogenous changes in the prices of products, prices of factors having perfectly elastic supplies, shifters of the supply of factors assumed to have other than perfectly elastic supply functions for the region, shifters of firm production possibilities, and changes in the number of firms. The second equation of the model explains changes in the number of firms as a function of these same exogenous variables and exogenous shifters of firm supply functions in each industry.

Mathematical Models of Equilibration Process

Changes in the production of products and utilization of resources in a region can be observed at several levels of aggregation with each level providing a different insight about the impact of changes. This dynamic process centers around three focal points. At the firm level, product supplies and factor demands can be influenced by changes

in production possibilities or product and factor prices. The second area concerns the aggregate effects of the micro adjustments reflected in firms' product supplies and factor demands. Interaction of variation in the number of firms with changes initiated at the micro or macro level represents the third area.

Variation in product demands and factor supplies emanating from the market level or from more disaggregated levels of specific types of product demanders or resource suppliers can also be considered. For this model, however, specification of the determinants of local employment and firm number changes are under consideration and only variation at the aggregate level for these two types of functions are considered as being important to overall adjustments in a region's economy. Consequently, product demand and factor supply functions, except for one critical factor (the n^{th} factor), were assumed perfectly elastic.

The general regional model of adjustments consists of three basic types of components.¹ These are (1) product supplies and factor demands for all firms in individual types of industries, (2) aggregate product demand and factor supply functions, and (3) the number of firms in each industry. Changes in any of the exogenous components can have substantial effects on regional adjustments at all levels of aggregation because of the relationships among the various functions. Primary causes of this interaction are changes in the prices of products and factors which occur at the aggregate level but still have an important impact on product output and resource input decisions made by individual firms. Firm adjustments emanating from changes at the aggregate level may result in

¹The complete model is specified in Appendix A.

changes in the number of firms which lead to additional changes at the aggregate level involving still further price adjustments. An equilibrium would exist when all product and factor prices and the number of firms in the industry are consistent with their total demand and supplies.

For small areas or regions such as a county or group of counties, the majority of product and factor prices might be realistically assumed fixed since regional adjustments within the area would not likely have a significant influence on the total market for these commodities. Feedback effects associated with adjustments would operate primarily within factor markets since nearly all product prices, with the exception of those products produced for local markets, would be mostly exogenous to an individual region unless it accounted for a significant proportion of the total national production of a commodity. Governmental price support activities could also contribute to fixing some agricultural product prices faced by farm firms in any given area. The probable existence of fixed product prices in the analysis of regional adjustment or equilibration allows one to assume that the product demands and the supplies of all but the critical factors are perfectly elastic for a region in which firms in k different types of industries exist and produce m different kinds of products with $n-m$ different kinds of factors. Firms within each of the k industry groups are assumed to have similar production possibilities and be operated by basically the same type of entrepreneur.

The remaining part of this chapter is concerned with the discussion of both changes in employment and firm numbers. First, an equation explaining the effects of the various shifters on employment is discussed. Then, a similar discussion of changes in firm numbers is outlined and finally, a discussion of both equations in a simultaneous context is given.

Changes in Employment

Using the assumptions discussed above, the change in demand for labor (employment) in a given industry, k , can be expressed as²

$$\begin{aligned}
 (2.1) \quad dQ_{Lk} = & \sum_{f=1}^t \left[b_{Lkn} \left(\frac{1}{A} \right) S_f \right] dX_f \\
 & + \sum_{j=1}^m \left[d_{Lkj} - b_{Lkn} \left(\frac{1}{A} \right) d_{nkj} \right] dP_j \\
 & + \sum_{i=m+1}^{n-1} \left[d_{Lki} - b_{Lkn} \left(\frac{1}{A} \right) d_{nki} \right] dP_i \\
 & + \sum_{h=1}^v \left[d_{Lkh} - b_{Lkn} \left(\frac{1}{A} \right) d_{nkh} \right] dZ_h \\
 & + \left[q_{Lk}^o - b_{Lkn} \left(\frac{1}{A} \right) q_{nk}^o \right] dN_k
 \end{aligned}$$

where

b_{Lkn} = change in quantity of labor demanded in the k^{th} industry associated with a one-unit change in price of the n^{th} factor.

A = difference in total quantity of the n^{th} factor demanded and supplied at a price one-unit above the equilibrium price for the n^{th} factor.

S_f = change in total quantity supplied of the n^{th} factor associated with a one-unit change in the f^{th} exogenous shifter for the n^{th} factor supply.

²The complete model from which equation (2.1) is derived and a detailed treatment of the derivation and equilibration process associated with the exogenous shifters is presented in Appendix A. Table 15, Appendix A, gives a mathematical definition of the terms in the equation.

d_{Lkj} = change in quantity of labor demanded in the k^{th} industry associated with a one-unit change in price of the j^{th} product.

d_{nkj} = change in quantity of the n^{th} factor demanded in the k^{th} industry associated with a one-unit change in price of the j^{th} product.

d_{Lki} = change in quantity of labor demanded in the k^{th} industry associated with a one-unit change in price of the i^{th} factor.

d_{nki} = difference in total quantity of the n^{th} factor supplied and demanded resulting from a one-unit change in price of the i^{th} factor.

d_{Lkh} = change in quantity of labor demanded in the k^{th} industry associated with a one-unit change in the h^{th} exogenous shifter of firm production possibilities.

d_{nkh} = change in quantity of the n^{th} factor demanded in the k^{th} industry associated with a one-unit change in the h^{th} exogenous shifter of firm production possibilities.

q_{Lk}^0 = quantity of labor demanded by a firm in the k^{th} industry.

q_{nk}^0 = quantity of the n^{th} factor demanded by a firm in the k^{th} industry.

Economic Interpretation of Employment Effects

Any discussion of the equilibration process on the demand for labor associated with the exogenous shifters in the model must necessarily

be preceded by a discussion of the economic interpretation of the various types of terms found in equation (2.1). Two terms appear in each coefficient of the equation. The first of these is

$$b_{Lkn} = N_k^0 \frac{\partial q_{Lk}}{\partial P_n}$$

which represents the change in the total quantity of labor demanded in the k^{th} industry associated with a one-unit change in price of the n^{th} factor. N_k^0 represents the total number of firms in the k^{th} industry, while $\frac{\partial q_{Lk}}{\partial P_n}$ represents the change in quantity of labor demanded by a firm in the k^{th} industry associated with a one-unit change in price of the n^{th} factor.

The second term is

$$A = \sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_n} - \frac{\partial S_n}{\partial P_n}$$

which represents the amount by which the total demand for the n^{th} factor would be less than the supply at a price one-unit above its equilibrium level. The portion $\sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_n}$ represents the number of firms in the k^{th} industry times the change in the quantity of the n^{th} factor demanded by a firm in the k^{th} industry associated with a one-unit change in price of the n^{th} factor summed over all industries. The portion $\frac{\partial S_n}{\partial P_n}$ represents the total change in the quantity of the n^{th} factor supplied in the area associated with a one-unit change in price of the n^{th} factor. The absolute value of A (or $-A$) represents the increase in demand or decrease in supply for this factor consistent with a one-unit change in price of the factor. The negative reciprocal can then be interpreted as the approximate change in price for each unit increase in demand or decrease in supply of the n^{th} factor resulting from exogenous shifters in the model.

The magnitude of this reciprocal would ultimately depend on the elasticities of the demand and supply functions involved since the elasticities would determine the magnitude of the quantity change associated with a given price change. Assuming constant elasticities within the relevant range, $\left(\frac{-1}{A}\right)$ would represent the decrease in price for each unit decrease in the demand or increase in the supply of this factor.

Three coefficients contain other terms that are very similar. The terms d_{Lkj} , d_{Lki} , and d_{Lkh} represent the direct change in quantity of labor demanded in the k^{th} industry associated with a one-unit change in the j^{th} product price, i^{th} factor price, or h^{th} shifter of firm production possibilities, respectively. Similarly, d_{nkj} and d_{nkh} represent the change in quantity of the n^{th} factor demanded in the k^{th} industry associated with a one-unit change in price of the j^{th} product and in the h^{th} shifter of firm production possibilities, respectively. The term, d_{nki} , represents the difference in total quantity of the n^{th} factor supplied and demanded associated with a one-unit change in price of the i^{th} factor. The mathematical construction of these terms is similar to that discussed for b_{Lkn} with the appropriate notational changes made as shown in Table 15, Appendix A.

Interpretation of these terms becomes even more meaningful when discussed simultaneously. For example, $\left(\frac{1}{A}\right)$ is the approximate change in price of the n^{th} factor associated with each unit change in total demand or supply of the n^{th} factor, and d_{nkj} is the change in total quantity of the n^{th} factor demanded in the k^{th} industry associated with a one-unit change in price of the j^{th} product. Their product, $\left(\frac{1}{A}\right) d_{nkj}$, represents the total price change for the n^{th} factor associated with a one-unit change in price of the j^{th} product. Final multiplication of this term by

b_{Lkn} , which represents the change in quantity of labor demanded in the k^{th} industry associated with a one-unit change in price of the n^{th} factor, gives $b_{Lkn} \left(\frac{1}{A}\right) d_{nkj}$, which may be interpreted as the total change in the quantity of labor demanded in the k^{th} industry resulting from a one-unit change in the j^{th} product price operating through the n^{th} factor market. This might be referred to as the indirect effect on labor demanded in the k^{th} industry resulting from an exogenous change in the j^{th} product price. The direct effect of this price term would be indicated by d_{Lkj} and would complete the coefficient of dP_j . All other terms in each coefficient would be interpreted in a similar manner.

Changes in Firm Numbers

Assuming only one critical factor, the change in the number of firms in the k^{th} industry can be expressed as³

$$\begin{aligned}
 (2.2) \quad dN_k = & - \sum_{f=1}^t \left[a_{kn} \left(\frac{1}{B} \right) S_g \right] dX_f \\
 & + \sum_{d=1}^s \left[\lambda_{kd} + a_{kn} \left(\frac{1}{B} \right) D_d \right] dW_d \\
 & + \sum_{j=1}^m \left[a_{kj} + a_{kn} \left(\frac{1}{B} \right) U_j \right] dP_j \\
 & - \sum_{i=m+1}^{n-1} \left[a_{ki} - a_{kn} \left(\frac{1}{B} \right) L_i \right] dP_i \\
 & + \sum_{h=1}^v \left[c_{kh} + a_{kn} \left(\frac{1}{B} \right) M_h \right] dZ_h
 \end{aligned}$$

³The complete model from which equation (2.2) is derived and a detailed treatment of the derivation and equilibrium process associated with the exogenous shifters is presented in Appendix A. Table 16, Appendix A, gives a mathematical definition of the terms in the equation.

where

a_{kn} = change in the number of firms in the k^{th} industry associated with a change in residual returns brought about by a one-unit change in the price of the n^{th} factor.

B = excess demand for the n^{th} factor associated with a one-unit change in price of the n^{th} factor.

S_f = change in total quantity supplied of the n^{th} factor associated with a one-unit change in the f^{th} exogenous shifter of the n^{th} factor supplies.

λ_{kd} = change in the number of firms in the k^{th} industry associated with a one-unit change in the d^{th} exogenous shifter of firm entrepreneur supply.

D_d = change in total demand for the n^{th} factor associated with a one-unit change in the d^{th} exogenous shifter of firm entrepreneur supply.

a_{kj} = change in the number of firms in the k^{th} industry associated with a change in residual returns brought about by a one-unit change in price of the j^{th} product.

U_j = change in demand for the n^{th} factor associated with a one-unit change in price of the j^{th} product.

a_{ki} = change in the number of firms in the k^{th} industry associated with a change in residual returns brought about by a one-unit change in price of the i^{th} factor.

L_i = difference in total quantity of the n^{th} factor that would be demanded and supplied resulting from a one-unit change in price of the i^{th} factor.

c_{kh} = change in the number of firms in the k^{th} industry associated with a change in residual returns brought about by a one-unit change in the h^{th} exogenous shifter of firm production possibilities.

M_h = change in demand for the n^{th} factor associated with a one-unit change in the h^{th} exogenous shifter of firm production possibilities.

Economic Interpretation of Firm Number Effects

Interpretation of the terms in equation (2.2) must also begin with a discussion of those terms appearing in each coefficient and those whose definitions are quite similar. Schrimper [18] provides a detailed discussion of coefficients from a somewhat similar equation expressed in terms of elasticities and percentage changes. Equation (2.2) represents the sum of effects associated with shifters of factor supplies, shifters of firm entrepreneur supply, product demands, factor supplies, and shifters of firm production possibilities on the number of firms. Each of these shifters operates through either a direct shift in the number of firms or through changes in firm residual returns resulting indirectly from these changes and from changes in use of the critical factor.

Two terms appear in each coefficient of the equation. The first of these is

$$a_{kn} = \sum_{e=1}^r \frac{\partial N_k}{\partial \Pi_e} q_{ne}^0 N_e^0 = \sum_{e=1}^r \frac{\partial N_k}{\partial P_n}$$

as derived in Appendix A and shown in Table 16. This term represents the change in the number of firms in the k^{th} industry associated with change in residual return brought about by a one-unit change in price of the n^{th} factor. The second term is defined as

$$B = \left(\sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_n} - \frac{\partial S_n}{\partial P_n} \right) - \sum_{k=1}^r q_{nk}^0 a_{kn}$$

which represents the excess demand for the n^{th} factor associated with a one-unit change in price of the n^{th} factor. The first portion of B is identical to A as defined for equation (2.1). The second portion takes into account some of the feedback effects on the quantity of the n^{th} factor demanded resulting from changes in the number of firms that are associated with a change in residual return brought about by a one-unit price change for the n^{th} factor. The reciprocal of this term, $\left(\frac{1}{B}\right)$, can then be interpreted in the same manner as $\left(\frac{1}{A}\right)$. The negative reciprocal, $\left(-\frac{1}{B}\right)$, can be interpreted as the approximate change in price of the n^{th} factor for each unit decrease in total demand or increase in supply of the n^{th} factor after adjustments resulting from exogenous shifters in the model.

The term λ_{kd} represents the change in the number of firms associated with a one-unit change in the d^{th} shifter of firm entrepreneur supply. Three additional terms that are very similar in nature are a_{kj} , a_{ki} , and c_{kh} . These terms are similar in mathematical construction and interpretation to a_{kn} . They are interpreted as the change in the number of firms associated with a change in residual return brought about by a one-unit change in j^{th} product price, i^{th} factor price, and h^{th} shifter of firm production possibilities, respectively. Each of these terms is treated mathematically in Appendix A and Table 16.

The term D_d may be interpreted as the change in demand for the n^{th} factor associated with a one-unit change in the d^{th} shifter of firm entrepreneur supply. Two terms that are similar to D_d in that they represent demand and supply relationships for Q_n under alternative price changes are U_j and L_i . Price changes in the j^{th} product are considered in U_j . The

first part of U_j , $\sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_j}$, represents the change in demand for the n^{th} factor associated with a one-unit change in price of the j^{th} product.

The second part, $\sum_{k=1}^r q_{nk}^0 a_{kj}$, takes into account the feedback effects on changes in the number of firms of a change in j^{th} product price as it is felt through changes in the residual return. Both parts of this term would have positive signs.

The first part of L_i , $\left(\frac{\partial S_n}{\partial P_i} - \sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_i} \right)$, represents the difference in supply and demand for the n^{th} factor at its initial equilibrium price after a one-unit increase in price of the i^{th} factor, assuming no change in firm numbers. The second part,

$\sum_{k=1}^r q_{nk}^0 a_{ki}$, takes into account the effects on demand for the n^{th} factor resulting from changes in the number of firms brought about by a one-unit change in P_i as felt through a change in residual return. Both these terms would tend to operate in the same direction. The first part of L_i differs from the first part of U_j since factor supplies were assumed to depend on possibly more than one factor price but be independent of product prices. Existing relationships between the n^{th} factor supply and changes in i^{th} factor prices would regulate this movement to some degree.

The last term, M_h , is also composed of two parts. The first part, $\sum_{k=1}^r N_k^o \frac{\partial q_{nk}}{\partial Z_h}$, represents the change in quantity demanded of the n^{th} factor associated with a one-unit change in the h^{th} exogenous shifter of firm production possibilities. The second part takes into account the change in the number of firms as it affects the n^{th} factor demand. This feedback effect is reflected through residual return changes resulting from a one unit change in the h^{th} shifter of firm production possibilities. Changes in the h^{th} shifter could be either output increasing and/or input decreasing as explained and footnoted in Appendix A and Table 16.

Again, as in equation (2.1), the product of each term in the coefficients gives total meaning to each coefficient. For example, in the coefficient of dX_f , the product of $\left(\frac{1}{B}\right) S_f$ would be interpreted as the total price change for the n^{th} factor associated with a one-unit change in X_f , since S_f is the change in quantity of the n^{th} factor supplied as a result of a one-unit change in X_f and $\left(\frac{1}{B}\right)$ is the n^{th} factor's price change for each unit change in the quantity. Further multiplication by a_{kn} , which represents the change in the number of firms associated with a change in residual return brought about by a one-unit change in P_n , would then give the total change in the number of firms associated with a one-unit change in X_f . The multiplicative effects of terms in each of the other coefficients would be interpreted similarly.

Economic Interpretation of Exogenous Changes

Changes in the demand for labor were expressed as a function of changes in shifters of factor supplies, product prices, factor prices, firm production possibilities, and the number of firms. Changes in the

number of firms were then expressed as a function of the same shifters of factor supplies, product prices, factor prices, firm production possibilities and shifters of firm entrepreneur supply. Each equation, (2.1) and (2.2), was derived from the same basic model as shown in Appendix A. Considered simultaneously, these equations then explain the changes occurring in an area economy as the result of changes in the exogenous variables. These processes are discussed separately in the following sections.

Factor Supplies

Changes in factor supplies in each equation are represented by dX_f . All changes in factor supplies occur in the supply of the factor assumed to be other than perfectly elastic. Equilibration resulting from an exogenous shift in factor supplies is demonstrated graphically in Figures 1 through 4. Figure 1 demonstrates the entire process while Figures 2, 3, and 4 outline in more detailed form the actual changes occurring in three of the five segments of Figure 1.

The effect of a change in supply of the n^{th} factor is indicated in Figures 1 (b) and 2 as the shift from S_n to S'_n with the resultant increase in Q_n^0 to Q'_n and decrease from P_n to P'_n . Shown in Figure 2 is the total change in quantity of the n^{th} factor indicated by

$$\frac{\partial S_n}{\partial X_f} dX_f \text{ and the total price change as indicated by } \left(-\frac{1}{A}\right) \frac{\partial S_n}{\partial X_f} dX_f.$$

Since $\left(\frac{1}{A}\right)$ represents the change in P_n associated with a one unit change in Q_n , $\left(\frac{1}{A}\right)$ would be negative as indicated since Q_n increases and the demand curve for the n^{th} factor is negatively sloped. This decrease in P_n would then cause an increase in residual returns to firms in the k^{th} industry as reflected in the shift from R_k to R'_k in Figures 1(d) and 3.

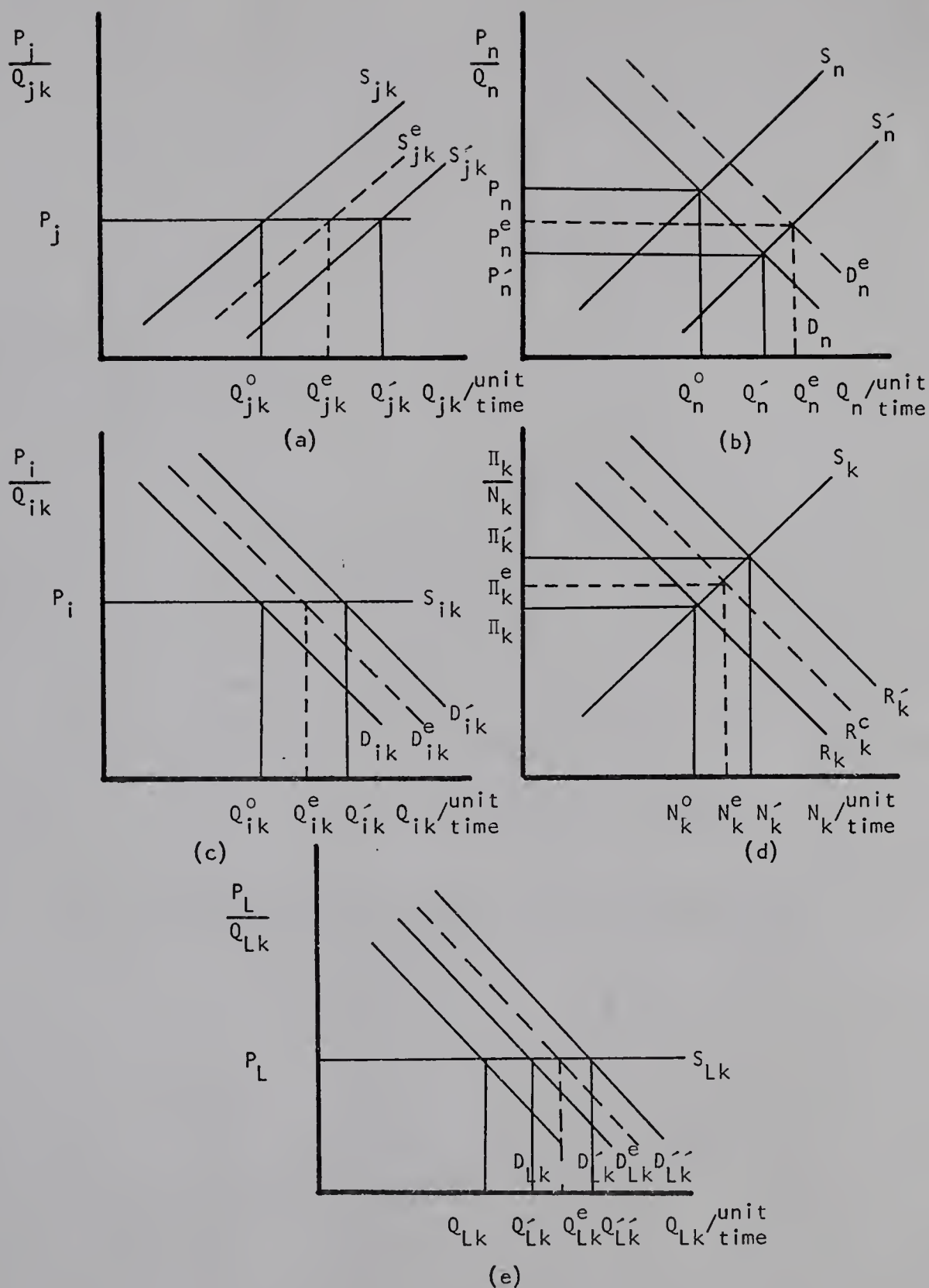


Figure 1. Illustration of the equilibration process resulting from a change in supply of the n^{th} factor.

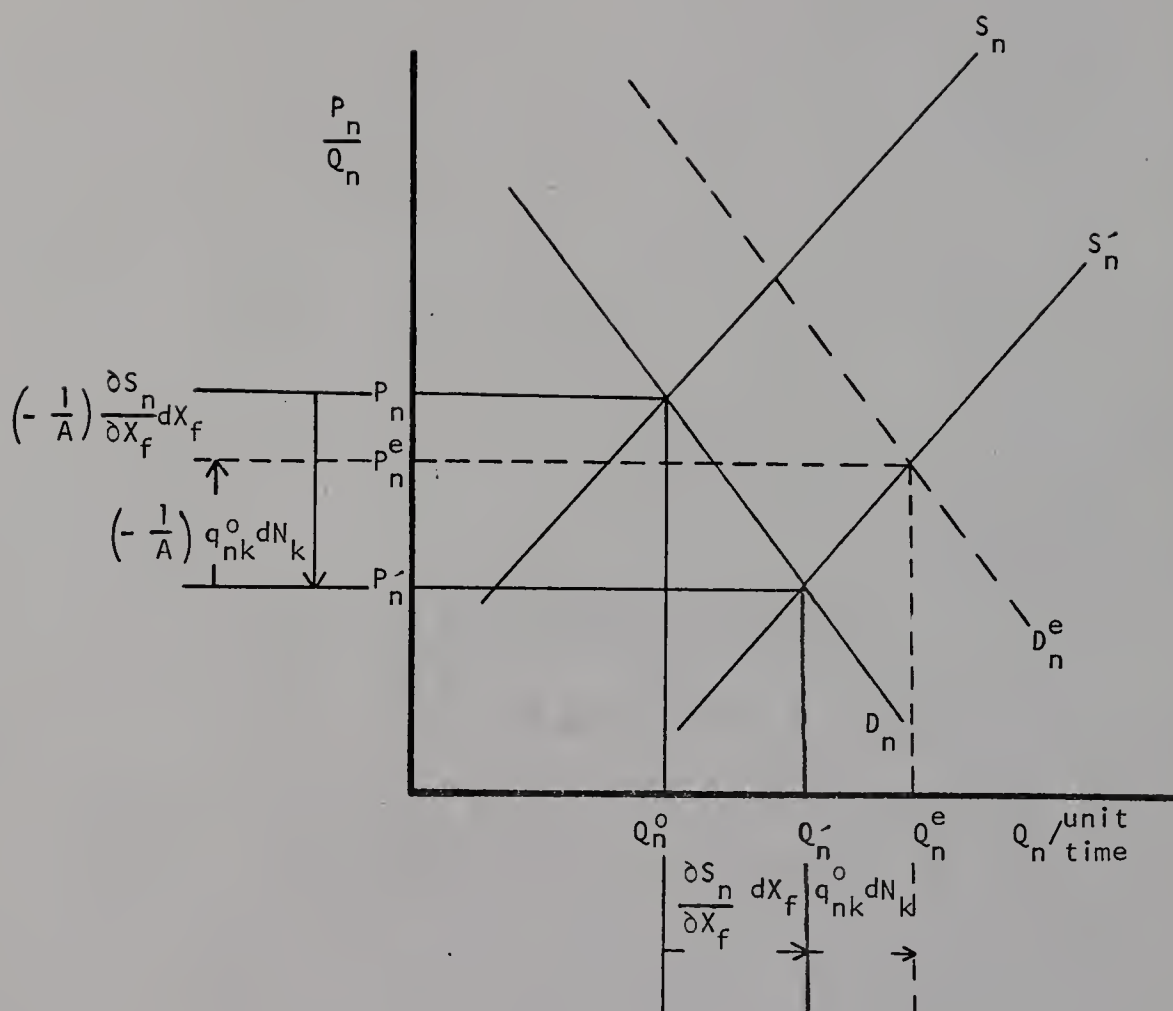


Figure 2. Illustration of the equilibration process in the n^{th} factor market resulting from a change in supply of the n^{th} factor.

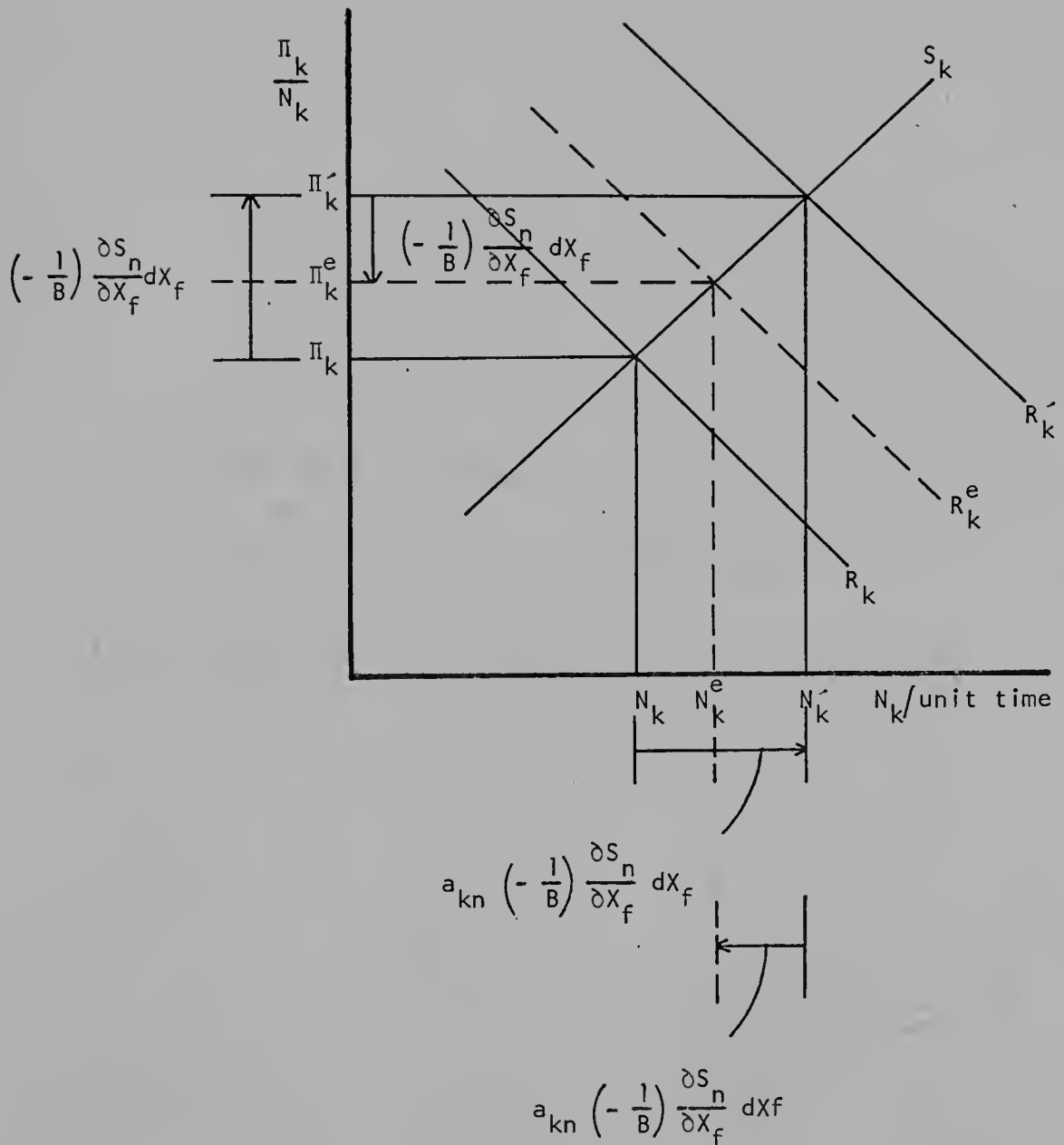


Figure 3. Illustration of the equilibration process in the firm entrepreneur market resulting from a change in supply of the n^{th} factor.

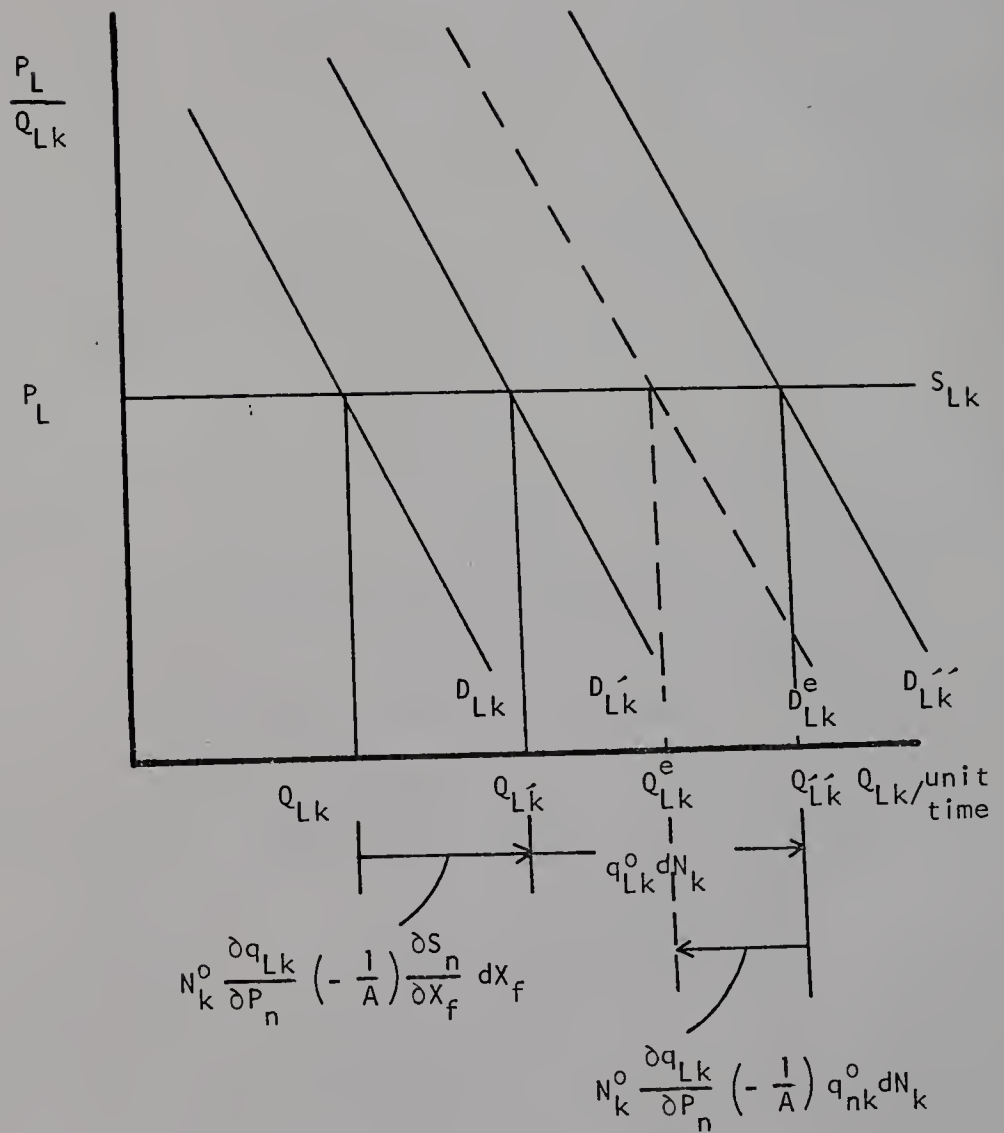


Figure 4. Illustration of the equilibration process in the labor market resulting from a change in supply of the n^{th} factor.

The effect of this shift would be the movement from N_k to N'_k as

indicated by $a_{kn} \left(-\frac{1}{B}\right) \frac{\partial S_n}{\partial X_f} dX_f$ and the movement from Π_k to Π'_k as indicated by $\left(-\frac{1}{B}\right) \frac{\partial S_n}{\partial X_f} dX_f$ in Figure 3. Resulting from an increase in the

number of firms would be an increase in the supply of the j^{th} product by the k^{th} industry, S_{jk} to S'_{jk} with the new quantity measured as Q'_{jk} as shown in Figure 1(a). Accompanying this increase would be an increase in demand for the i^{th} factor shown in Figure 1(c) as the shift from D_{ik} to D'_{ik} with Q'_{ik} indicating the new quantity demanded. The final initial result would be an increase in the demand for labor as shown by the shift from D_{Lk} to D'_{Lk} in Figures 1(e) and 4. This total shift comes from two sources. The first is a direct result of the shift in X_f as shown by

$N_k^0 \frac{\partial q_{Lk}}{\partial P_n} \left(-\frac{1}{A}\right) \frac{\partial S_n}{\partial X_f} dX_f$ and indicated by the movement from Q_{Lk} to Q'_{Lk} in

Figure 4. The remainder of the increase in labor demand comes from an increase in the number of firms resulting from increases in residual returns through lower prices of P_n . This increase is given by $q_{Lk}^0 dN_k$ as the movement from Q'_{Lk} to Q''_{Lk} in Figure 4.

Entrance of new firms to the k^{th} industry would ultimately increase the demand for the critical factor as indicated by the shift from D_n to D_n^e in Figures 1(b) and 2. The resultant shift in Q'_n to Q_n^e is indicated in Figure 2 by $q_{nk}^0 dN_k$. Resulting from this would be a bidding upward of P'_n to P_n^e as shown by $\left(-\frac{1}{A}\right) q_{nk} dN_k$ in Figure 2. Since $\left(-\frac{1}{A}\right)$ represents the decrease in price for each unit decrease in demand, an increase in demand, i.e., the movement from D_n to D_n^e , would cause a price increase as shown. Increases in P_n would then result in the exit of some firms from the k^{th} industry through a decrease in the residual

return to these industries. This decrease in return is shown by the shift from R'_k to R_k^e in Figures 1(d) and 3. The effect of a price increase through $\left(-\frac{1}{B}\right)$ then causes the movement from Π'_k to Π_k^e as indicated in Figure 3. A similar response in the movement from N'_k to N_k^e is also shown. Resultant shifts would also occur in S'_{jk} and D'_{ik} . Equilibrium positions would be indicated by S_{jk}^e and D_{ik}^e with equilibrium quantities indicated by Q_{jk}^e and Q_{ik}^e in Figures 1(a) and 1(c), respectively.

The final movement requiring discussion concerns that in the labor market. Changes in P_n resulting from increases in demand for the n^{th} factor also cause a final shift in the labor demand function as indicated by the shift from D'_{Lk} to D_{Lk}^e in Figures 1(e) and 4. Again since $\left(-\frac{1}{A}\right)$ represents the decrease in price of the n^{th} factor associated with decreases in demand, the price increase occurring as a result of the increased demand from new firms as felt through $\left(-\frac{1}{A}\right)$ would partially affect the earlier increase in the quantity of labor demanded as indicated through the term, $N_k^o \frac{\partial q_{LK}}{\partial P_n} \left(-\frac{1}{A}\right) q_{nk}^o dN_k$, with equilibrium quantity demanded at Q_{Lk}^e as shown in Figure 4.

A similar analysis could be performed for each of the remaining four exogenous shifters in the model. Each discussion would center around the equilibration process as reflected through the appropriate terms in equations (2.1) and (2.2). However, due to their similarities and the complete treatment given dX_f , only a brief discussion is given for the remaining shifters in the following sections.

Number of Firm Entrepreneurs

The initial effect of an increase in an exogenous shifter of the number of firm entrepreneurs would, of course, be an increase in the number of firms in a given industry. Consequently, the residual return to each firm in the industry would decline as the result of both increases in the number of firms and increases in demand for the n^{th} factor which would increase its price. The quantity of the j^{th} product produced would initially increase along with the quantities demanded of the i^{th} factor and labor. Ultimately, price increases for the n^{th} factor would result in declines in residual returns to firms and lead to fewer numbers of firms. Quantities of the j^{th} product produced would then decline, along with the quantity demanded of the i^{th} factor and labor. Equilibrium quantities would be expected to remain above their initial values as the result of the initial upward shift outweighing secondary changes due to the reduction in the number of firms. The actual quantities of factors utilized would depend on their substitutability for the n^{th} factor and the increase in the number of firms. Even though the n^{th} factor and labor might possibly substitute, as the price of the n^{th} factor increased, the overall effect should be an increase in quantity demanded of all factors as well as in the number of firms.

Product Price

Increases in product prices (upward shifts in perfectly elastic product demands) would directly affect the residual return to firms and cause firm numbers to increase. As firm numbers increase, the demand for the n^{th} factor would increase, and since its supply function is other than perfectly elastic its price would increase. Simultaneous increases would also occur in the quantities of labor and the i^{th} factor demanded. Ultimately, as the price of the n^{th} factor increased the

residual return to firms would decrease accompanied by a decrease in the number of firms. This would cause a decrease in the quantities demanded of labor, the i^{th} factor, and the n^{th} factor. Equilibrium conditions would be expected to result in an increase in the quantity of labor demanded as well as in the number of firms from the initial levels before the product price change.

Factor Price

Changes in factor prices, representing a shift in factor supplies assumed to be perfectly elastic, operate in an opposite manner than product price changes. As factor prices increase, the residual return to firms becomes smaller, thus directly causing a decrease in the number of firms. Initially the quantity of the j^{th} product produced, quantities of the n^{th} factor demanded, and quantity of labor demanded will decrease. These decreases would be offset somewhat by their substitutability for the i^{th} factor. As the price of the n^{th} factor declines as the result of smaller quantities demanded, existing firms would experience increased residual returns and, thus, new firms would be enticed to enter the industry thus increasing the demand for the n^{th} factor, the i^{th} factor, and labor, as well as increasing the quantity of product produced. Depending on the elasticity of substitution among factors and the relative magnitudes of the various changes occurring throughout the equilibration process, equilibrium increases in the quantities of labor and the n^{th} factor demanded might occur simultaneously with the decreases in the quantities of product output, i^{th} factor demanded, and the number of firms.

Firm Production Possibilities

Changes in firm production possibilities which are output increasing and/or input decreasing result in higher residual returns to firms and thus increases in firm numbers. Entrance of new firms would increase the output of product, quantity of both labor and the i^{th} factor demanded and bid up the price of the n^{th} factor through increases in its demands. Increases in the n^{th} factor price would ultimately lead to a decline in returns and cause an offsetting effect by reducing the number of firms. This decrease would then lead to a decrease in output, and decreases in quantities demanded of the i^{th} factor and labor. Equilibrium quantities, however, would be expected to be greater than the initial quantities.

CHAPTER III

STUDY AREA AND MODEL SPECIFICATION

One of the major objectives of this research was to determine the importance of natural resource investments and other types of investments in influencing employment changes in recipient areas. Particular interest was given to investments in critical resources including water and other forms of capital investment. For research such as this to be applicable in other areas some level of confidence must be maintained that knowledge acquired through research in a particular geographical area is transferable to other areas. If there is some question as to the applicability of research results among areas then the information becomes quite limited in use. Since regions differ in geographic, institutional, sociological, and economic characteristics one cannot conclude that natural resource investments stimulate employment in general without some regard to these different regional characteristics.

Study Area

The four-state region of Mississippi, Alabama, Georgia, and Florida containing 375 counties was chosen as the study area. The area was delineated into two groups of homogenous subareas. Counties in the four states were classified into two groups on the basis of a set of ten variables depicting the county's human and natural resource endowments, and its urban, industrial, and agricultural structure. These ten

variables were 1960 measures of (1) population, (2) urban population, (3) percent of persons 25 years old and over with a high school education, (4) median age, (5) total employment, (6) total agricultural employment, (7) total manufacturing employment, (8) land area, (9) land in farms, and (10) value of farm products sold.

Discriminant analysis was used in this delineation. Counties were grouped initially into two groups. A linear function of the differences of the means between the two groups was found which discriminated most successfully between the two groups. A general mean was then derived by substituting the means of all variables into the function. The function was then used to derive a mean for each county using county observations on each variable. Counties having values above the general mean were placed in one group and those having means below the general mean were placed in the second group. The process was repeated until the number of misclassified counties was minimal. Computational procedures of the technique are outlined by Martin [21]. Additional discussion of the discriminant analysis technique is also provided by Tintner [22, pp. 96-102]. Several other variables were used with the above ten in grouping the counties, but their relative lack of importance in the discriminant function excluded them from consideration in the final delineation process. The most important variables in the delineation process were median age, education level, land area, agricultural employment, and total employment. Characteristics of the two groups were as expected. For example, the urban counties had higher average educational levels and higher average total employment. The nonurban group had higher average agricultural employment levels.

Some judgement was warranted as to the meaningfulness of the delineations by persons familiar with the four-state region. Members of

the Southern Land Economics Research Committee¹ from each of the four states were asked to evaluate the initial classifications for their state. These evaluations were used to adjust the mathematical delineations and resulted in the final grouping shown in Figure 5. About one-fourth of the counties (91) represent the more urban-oriented group while the remaining counties (284) exhibit a more rural orientation.

Analyses were carried out for three groupings of counties. All counties in the four-state region constituted one group. The urban counties and nonurban counties formed the remaining two groups. Effects of similar investments in human, natural, and capital resources in these dissimilar areas should provide results that would be expected in other areas. For example, information on the effects of investments in urban-oriented versus the rural-oriented areas could provide guidelines on what types of investments should stimulate employment in the same types of areas in other regions of the country.

Selection of Employment Categories

Some categorization of employment is necessary to insure a meaningful analysis. Employment is reported on the basis of either occupational or industrial classifications. Occupational categories include such classifications as the various types of laborers, craftsmen, and professional workers, while the industrial classification distinguishes among the various industries such as agriculture, construction, textile products, and metals. The various types of investment in

¹This committee consists of representatives from eleven southern land-grant universities, several federal agencies, and is supported in part by the Farm Foundation, Chicago, Illinois.

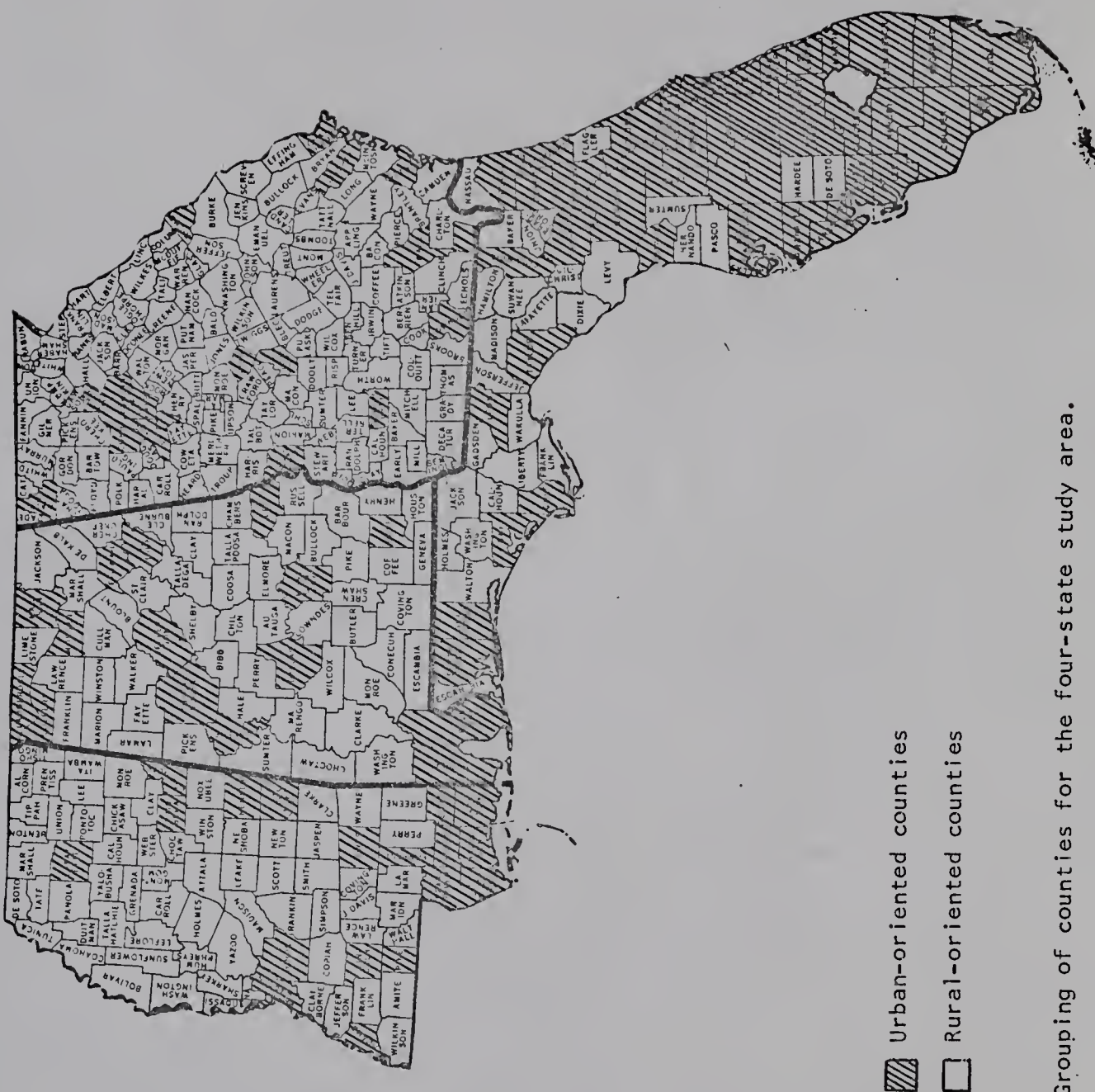


Figure 5. Grouping of counties for the four-state study area.

human, natural, and capital resources could affect employment in each occupational or industry category in a different way. Industrial classification lends itself to a more meaningful analysis from the standpoint of the theoretical framework outlined in Chapter 11. Also secondary data on industrial classification are more readily available. The industrial classification was, therefore, used to distinguish among employment categories in the analysis.

Industry selection was made primarily according to the number of employees. Agriculture, construction, five individual manufacturing industries, and durable and nondurable manufacturing were selected for analysis (Table 1). These industries are likely candidates for growth-generating activities with growth in the remaining industries being dependent on them. For this reason, and since data of the nature needed for this study are not readily available for the more service-oriented industries, the service industries such as wholesale and retail trade, finances, and communications were not included in the analysis. Also, the initial employment effects of investments in natural resources would most likely be felt in the industries selected.

Industries three through seven accounted for approximately 57 percent (762,098 employees) of all manufacturing employment in the four-state region in 1967 [23, pp. 1.7-1.11, 10.7-10.11, 11.9-11.13, 25.6-25.9]. The importance of construction and agriculture is shown in Table 1 where these industries rank one (460,771 employees) and three (286,528 employees), respectively, when compared to employment in the individual manufacturing industries [24, Table 54]. Employment data for construction and agriculture were for 1969.

Table 1. Industry identification and employment rankings for the four-state area (1967)

Industry identification for this study	Industry ^a	Standard industrial classifica- tion code (SIC)	Total four- state employment rank ^b
1	Agriculture	15-17	3
2	Construction	01, 07-09	1
3	Textile mill products and other fabricated textile products manufacturing	22, 23	2
4	Food and kindred products manufacturing	20	4
5	Transportation equipment manufacturing	37	5
6	Furniture, lumber, and wood products manufacturing	24, 25	6
7	Electrical equipment manufacturing	36	7
D	Durable products manufacturing	24-26, 32-34, 36, 37	-
ND	Nondurable products manufacturing	20, 22, 23, 28	-

^aSeveral industries were grouped together to make data from the U.S. Census of Population and the U.S. Census of Manufactures comparable for later uses in the study.

^bCalculated from: U.S. Bureau of the Census, Census of Manufactures, Area Statistics: 1967 (Washington, U.S. Government Printing Office), Vol. III, Part I, pp. 1.7-1.11, 10.7-10.11, 11.9-11.13, 25.6-25.9 and Census of Population: 1970 (Washington, U.S. Government Printing Office), Vol. I, Parts 2, 11, 12, and 26, Table 54.

Water usage of each industry was also examined since two of the natural resource investment programs included in the study are water oriented. Water use data for construction and agriculture are not available. Agriculture should benefit from drainage, flood control and an increased irrigation water supply. Analysis of national rank in water use for manufacturing industries² indicated that some of the largest water using industries have not been included in the analysis. The petroleum and coal industry is the third largest industrial water use in the U.S. However, this industry provided only .3 percent of the total four-state employment and thus was not included. Manufacture of stone, clay, and glass products, nonelectrical machinery, and rubber and plastics products accounted for only 5.5 percent of total four-state employment. Additionally, these industries ranked low in total U.S. water use. Although the stone, clay, and glass industry provides products required in building water control structures, the combination of low employment and inadequate county data provided sufficient basis for excluding these industries. Inadequate county data also resulted in the exclusion of both primary and fabricated metal products, paper and allied products, and chemicals and allied products, although chemicals and fabricated metals manufacturing rank one and two nationally in water use.

The five individual manufacturing industries included in the analysis ranged from fifth to twelfth among the rankings for all industries in national water use. Water investment projects of the Soil Conservation Service included in this study do not influence major industrial users of water. However, certain projects carried out by the

²National water use data are available in the Census of Manufactures [25, Vol. 1, pp. 7.16-7.17].

Corps of Engineers could influence the location and expansion of these industries. Water use by these industries is important in assessing employment changes due to investments in water resource programs.

General Model Specification

Economic interpretation of changes in the exogenous shifters involved in equations (2.1) and (2.2) in the previous chapter made it apparent that interaction occurs in both equations simultaneously.. Estimation of the effects of exogenous changes on employment and firm numbers could be considered using a system of equations. Figure 1 represents the simultaneous changes occurring as the result of a change in resource supplies. Total interaction as the result of all changes in the exogenous variables can be represented for each industry by a system of equations. The availability of n county observations for each industry gives the following general system for the k^{th} industry.

$$(3.1) \quad dQ_{Lkt} = \beta_{10} + \beta_{11}dx_{ft} + \beta_{12}dP_{jkt} + \beta_{13}dP_{ikt} + \beta_{14}dZ_{hkt} \\ + \gamma_{11}dN_{kt} + U_{1kt} \quad t = 1, 2, \dots, n$$

$$(3.2) \quad dN_{kt} = \beta_{20} + \beta_{21}dx_{ft} + \beta_{22}dP_{jkt} + \beta_{23}dP_{ikt} + \beta_{24}dZ_{hkt} \\ + \beta_{25}dW_{dkt} + U_{2kt} \quad t = 1, 2, \dots, n$$

where the subscript t represents county observations, and

dQ_{Lkt} = total change in the quantity of labor demanded
in the k^{th} industry (endogenous).

dx_{ft} = total change in the f^{th} shifter of the n^{th}
factor supply (exogenous).

dP_{jkt} = total change in product demands in the k^{th} industry (exogenous).

dP_{ikt} = total change in factor supplies in the k^{th} industry for all factors other than the n^{th} factor (exogenous).

dZ_{hkt} = total change in firm production possibilities for firms in the k^{th} industry (exogenous).

dN_{kt} = total change in the number of firms in the k^{th} industry (endogenous).

dW_{dkt} = total change in shifters of firm entrepreneur supply for firms in the k^{th} industry (exogenous).

The β coefficients and the parameters of the distribution are unknown which leaves the problem of obtaining estimates of these parameters.³ By rearranging equations (3.1) and (3.2) as

$$(3.3) \quad -dQ_{Lkt} + \gamma_{11}dN_{kt} + \beta_{10} + \beta_{11}dX_{ft} + \beta_{12}dP_{jkt} + \beta_{13}dP_{ikt} + \beta_{14}dZ_{hkt} = -U_{1kt}$$

$$(3.4) \quad -dN_{kt} + \beta_{20} + \beta_{21}dX_{ft} + \beta_{22}dP_{jkt} + \beta_{23}dP_{ikt} + \beta_{24}dZ_{hkt} + \beta_{25}dW_{dkt} = -U_{2kt}$$

³Estimates derived using the following model are consistent and asymptotically efficient if the following assumptions are made:

$$E [U_{(kt)}] = 0$$

$$E \begin{bmatrix} U_{(kt)} & U_{(k,t+s)} \end{bmatrix} = \begin{matrix} \Sigma & \text{if } s = 0 \\ 0 & \text{otherwise} \end{matrix}$$

$$E \begin{bmatrix} X_{(kt)}' & U_{(kt)} \end{bmatrix} = 0$$

they can conveniently be written in matrix notation as

$$(3.5) \quad \begin{bmatrix} -1 & \gamma_{11} \\ 0 & -1 \end{bmatrix} \begin{bmatrix} dQ_{Lkt} \\ dN_{kt} \end{bmatrix} + \begin{bmatrix} \beta_{10} & \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & 0 \\ \beta_{20} & \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \end{bmatrix} \begin{bmatrix} 1 & dX_{ft} & dP_{jkt} & dP_{ikt} & dZ_{hkt} & dW_{dkt} \end{bmatrix}' = \begin{bmatrix} -U_{1kt} \\ -U_{2kt} \end{bmatrix}$$

and finally condensed to

$$(3.6) \quad \Gamma Y_{(kt)} + \beta X_{(kt)} = U_{(kt)}$$

where

$$\Gamma = \begin{bmatrix} -1 & \gamma_{11} \\ 0 & -1 \end{bmatrix} \quad Y_{(kt)} = \begin{bmatrix} dQ_{Lkt} \\ dN_{kt} \end{bmatrix}$$

$$\beta = \begin{bmatrix} \beta_{10} & \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & 0 \\ \beta_{20} & \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \end{bmatrix}$$

$$X_{(kt)} = \begin{bmatrix} 1 & dX_{ft} & dP_{jkt} & dP_{ikt} & dZ_{hkt} & dW_{dkt} \end{bmatrix}'$$

$$U_{(kt)} = \begin{bmatrix} -U_{1kt} \\ -U_{2kt} \end{bmatrix}$$

The subscript k indicates that this particular system is for the k^{th} industry. Each industry under study would be represented by an equation of this general form. Equation (3.6) presents the simultaneous linear equation model in its structural form. Each of these sources provides a detailed discussion of simultaneous equation models, their assumptions, limitations, and possible problems which might arise in their application.

Structural Estimation

It is necessary that an equation in a set of simultaneous equations be just or over-identified before estimates of the parameters can be obtained. The order condition for identification can be used to determine whether a given equation is identified.⁴ If A is equal to the number of predetermined (exogenous) variables that do not appear in an equation and B refers to the number of endogenous variables in the equation, then the following conditions determine the identification of the equation.

$$\begin{aligned} A &= B - 1 && \text{just identified} \\ A &> B - 1 && \text{over identified} \\ A &< B - 1 && \text{under identified} \end{aligned}$$

Reduced Form Estimation

The complete structural system may be written so that each endogenous variable is expressed as a function of all exogenous variables appearing in the system. This representation of the system is referred to as the reduced form and brings out the explicit dependence of the dependent variables on the predetermined variables and the disturbances. Premultiplication of equation (3.6) by Γ^{-1} and rearrangement gives

$$(3.7) \quad Y_{kt} = -\Gamma^{-1}\beta X_{(kt)} + \Gamma^{-1}U_{(kt)}$$

or $(3.8) \quad Y_{kt} = \Pi X_{(kt)} + V_{(kt)}$

$$\text{where} \quad \Pi = -\Gamma^{-1}\beta = \begin{bmatrix} \Pi_{10} & \Pi_{11} & \dots & \Pi_{15} \\ \Pi_{20} & \Pi_{21} & \dots & \Pi_{25} \end{bmatrix}$$

⁴Goldberger [26, pp. 352-372] and Johnston [27, pp. 241-252] provide detailed discussions of the identification problem.

$$v_{(kt)} = \Gamma^{-1} u_{(kt)} = \begin{bmatrix} v_{1kt} \\ v_{2kt} \end{bmatrix}$$

Estimates from the reduced form may be derived directly by ordinary least squares since their disturbances are linear combinations of the structural disturbances.⁵ However, in general practice the structural parameters are estimated first and then the reduced form parameter estimates are obtained by use of $\Pi = -\Gamma^{-1}\beta$.

Individual Industry Models

A two-equation system was specified for agriculture according to the theoretical framework outlined in equations (2.1) and (2.2), and the general estimation model outlined in equations (3.1) and (3.2). Single equation models were specified for construction and the various manufacturing industries. These models are presented below with each variable coded similarly to equations (3.1) and (3.2). That is, changes in factor supplies are represented by X, changes in shifters of firm supply by W, changes in product demands by PP, changes in factor prices by FP, and changes in firm production possibilities by Z. Data sources for each variable are given in the latter sections of this chapter and the mathematical derivation is given in Appendix B.

⁵The assumptions for the reduced form disturbances are

$$E [v_{(kt)}] = \Gamma^{-1} E [u_{(kt)}] = 0$$

$$E [v_{(kt)} v'_{(kt)}] = E [(\Gamma^{-1} u_{(kt)}) (\Gamma^{-1} u_{(kt)})'] = \Gamma^{-1} \Sigma \Gamma^{-1} = \Omega \quad \text{for } t = t'$$

$$= 0 \text{ otherwise}$$

$$E [X_{(kt)} v'_{(kt)}] = 0$$

Agriculture

The system of equations representing the agricultural industry is

$$(3.9.1.1) \quad E_{1i} = \beta_{011} + \sum_{r=1}^6 \beta_{r11} X_{ri} + \beta_{711} PP_{1i} + \beta_{811} FP_{1i} \\ + \beta_{911} Z_{1i} + \beta_{10,11} GRP_i + \gamma_{11,11} N_{1i} + \mu_{111i}$$

$$(3.9.1.2) \quad N_{1i} = \beta_{012} + \sum_{r=1}^6 \beta_{r12} X_{ri} + \beta_{712} PP_{1i} + \beta_{812} FP_{1i} \\ + \beta_{912} Z_{1i} + \beta_{10,12} GRP_i + \beta_{11,12}^{WW} 1i + \beta_{12,12}^{WE} 1i \\ + \beta_{13,12}^{WA} 1i + \mu_{112i}$$

where the first subscript is the parameter number, the second subscript is the industry number, the third subscript is the equation number where

E_{1i} = Change in agricultural employment for the period 1960-1970 in the i^{th} county.

X_{1i} = Change in federal and state expenditures per pupil for primary and secondary education during the period 1960 to 1970 in the i^{th} county.

X_{2i} = Change in total construction expenditures in water development projects by the Corps of Engineers during the period 1960 to 1970 in the i^{th} county.

X_{3i} = Change in total construction expenditures in the PL-566 Small Watershed Program by the Soil Conservation Service during the period 1960 to 1970 in the i^{th} county.

X_{4i} = Change in total investment in the Agricultural Conservation Program (renamed the Rural Environmental Assistance

Program in 1971) by the Agricultural Stabilization and Conservation Service during the period 1960 to 1970 in the i^{th} county.

X_{5i} = Change in total loans and grants for community water and sewer systems and waste disposal systems made by the Farmers Home Administration during the period 1960 to 1970 in the i^{th} county.

X_{6i} = Change in acreage of allotment crops due to reduction in allotments between 1959 and 1969 weighted by the proportion of the total value of the allotment crop to total value of crops and livestock in the i^{th} county in 1959.

PP_{1i} = Change in price index of agricultural commodity groups during the period 1959-61 to 1969-71 weighted by the proportion of the value of the commodity group to the total value of crops and livestock in the i^{th} county in 1959.

FP_{1i} = Change in the average annual wage per hired farm worker during the period 1959 to 1969 in the i^{th} county.

Z_{1i} = Change in the Southeast index of agricultural output per man-hour for commodity groups during the period 1959-61 to 1969-71 weighted by the proportion of the value of the commodity group to total value of crops and livestock in the i^{th} county in 1959.

GRP_i = Intercept shifter dummy variable
with $GRP_i = \begin{cases} 1 & \text{when urban-oriented county} \\ 0 & \text{when rural-oriented county} \end{cases}$

N_{1i} = Change in the number of farms during the period 1959 to 1969 for the i^{th} county.

WW_{1i} = Change in total annual nonagricultural wage payments during the period 1960 to 1970 per agricultural employee in 1960 for the i^{th} county.

WE_{1i} = Change in total nonagricultural employment during the period 1960 to 1970 per agricultural employee in 1960 for the i^{th} county.

WA_{1i} = Change in the number of farm operators who were 55 or more years of age during the period 1959 to 1969 in the i^{th} county.

U_{111i}, U_{112i} = Disturbance terms.

The Greek letters β and γ represent the parameters to be estimated.

Variables endogenous to the system are E_{1i} and N_{1i} . Equation (3.9.1.1) is over-identified and equation (3.9.1.2) is just-identified.

Construction

Data availability on the construction industry precluded the calculation of changes in the product price and technology variables. Data on firm number changes also were inadequate. However, since the construction industry would be one of the more important in evaluating the primary employment effects of investments in natural resources a single equation model was formulated in this industry. The equation for the construction industry is

$$(3.9.2.1) \quad E_{2i} = \beta_{02} + \sum_{r=1}^5 \beta_{r2} X_{ri} + \beta_{62} FP_{1i} + \beta_{72} GRP_i \\ + \beta_{82} WW_{2i} + \beta_{92} WE_{2i} + \mu_{12i}$$

where

E_{2i} = Change in construction employment for the period 1960 to 1970 in the i^{th} county.

X_{1i} to X_{5i} = Same as in equation (3.9.1.1).

FP_{2i} = Change in average annual wages per construction employee during the period 1958 to 1967 for the i^{th} county.

GRP_i = Same as in equation (3.9.1.1).

WW_{2i} = Change in total annual wage payments during the period 1960 to 1970 for all nonagricultural and nonconstruction employees per construction employee in 1960 for the i^{th} county.

WE_{2i} = Change in total nonagricultural and nonconstruction employment during the period 1960 to 1970 per construction employee in 1960 for the i^{th} county.

U_{12i} = Disturbance terms.

Manufacturing

The remaining seven industries are manufacturing industries. A two-equation model did not yield results comparable to those obtained for agriculture. The number of manufacturing firms is much smaller and the size of firms (measured in terms of the number of employees) is generally larger than for the agricultural industry. Estimation of changes in the number of manufacturing firms did not add to the interpretive and explanatory power of the system of equations. Much of the impact of changes in the exogenous variables for manufacturing industries is transmitted through employment changes within existing firms rather than change in the number of firms. Therefore, changes in the number of firms in each manufacturing industry was treated as an exogenous variable and a single-equation model was specified for each manufacturing industry. This model is of the form

$$\begin{aligned}
 (3.9.k.1) \quad E_{ki} = & \beta_{0k} + \sum_{r=1}^5 \beta_{rk} X_{ri} + \beta_{6k} PP_{ki} + \beta_{7k} FP_{ki} \\
 & + \beta_{8k} Z_{ki} + \beta_{9k} GRP_i + \beta_{10,k} WWM_i + \beta_{11,k} WE_{ki} \\
 & + \beta_{12,k} N_{ki} + \mu_{ki}
 \end{aligned}$$

$$k = 3, 4, \dots, 7, D, ND$$

where

E_{ki} = Change in k^{th} industry employment for the period 1960 to 1970 in the i^{th} county.

X_{1i} to X_{5i} = Same as in equation (3.9.1.1).

PP_{ki} = Change in price index for each SIC three-digit level industry commodity group in the k^{th} industry during the period 1959-61 to 1969-71 weighted by the proportion of value added by the commodity group to total value added by the commodity group to total value added in the k^{th} industry in 1958 for the i^{th} county.

FP_{ki} = Change in average annual wages per production worker for each SIC three-digit level industry group in the k^{th} industry during the period 1958 to 1967 weighted by the proportion of production worker employment in each subgroup to total production worker employment in the k^{th} industry for the i^{th} county.

Z_{ki} = Change in the index of output per man-hour for each SIC three-digit level industry group in the k^{th} industry during the period 1959-61 to 1969-71 weighted by the proportion of value added by the commodity group to total value added in the k^{th} industry for the i^{th} county.

GRP_i = Same as in equation (3.9.1.1).

WW_{mi} = Change in total annual nonagricultural and non- k^{th} industry wage payments during the period 1960 to 1970 per k^{th} industry employee in 1960 for the i^{th} county.

WE_{ki} = Change in total nonagricultural and non- k^{th} industry employment during the period 1960 to 1970 per k^{th} industry employee in 1960 for the i^{th} county.

N_{ki} = Change in the number of firms in the k^{th} industry during the period 1959 to 1969 for the i^{th} county.

U_{ki} = Disturbance term.

The symbols β and γ represent the parameters to be estimated.

Model Estimation Procedure

Two-stage least squares⁶ was used to estimate the structural parameters of equations having the form of (3.9.1.1) in the two-equation system for agriculture. Ordinary least squares⁷ was used to estimate equations having the form of equation (3.9.2.1) in each of the uses of the two-equation models. This statistical procedure was also used for all single-equation models. Estimates of the reduced form coefficients for the two-equation models were derived from the structural parameter estimates.

⁶A computer program written by William James Raduchel [28] was used.

⁷Ibid.

Measurement of Variables and Empirical Expectations

Changes in employment and firm numbers as defined in equations (3.9.1.1) and (3.9.1.2) were considered as endogenous variables. In the model that forms a system of equations, the endogenous variables are considered functions of some or all predetermined (exogenous) variables. In the first equation employment changes were also considered as a function of the endogenous variable for firm number changes. Predetermined variables represent changes in exogenous shifters of product demand, factor price, critical resource supply, firm production possibilities or firm entrepreneur supply functions. Each of these general types of shifters is represented by one or more variables in each equation. Each variable, the type of shifter it represents, and the expected effects of changes in these variables on agricultural employment and the number of farms are given in Table 2. A similar illustration of the effects on construction and manufacturing employment is given in Table 3. Detailed discussion of each variable follows in the remaining sections of this chapter.

Employment

Changes in employment for each county were computed for the time period 1960 to 1970 as reported in the 1960 Census of Population [29, Table 85] and the 1970 Census of Population [24, Table 123]. Employment is reported in this source using basically the same industry categories as suggested by the Standard Industrial Classification (SIC) of industries. It was necessary to combine employment reported in some industries to conform to the industry classification shown in Table 1. Changes in employment were used as dependent variables.

Table 2. Expected effect of changes in predetermined variables on agricultural employment and farm numbers

Variable		Direction of change for variable	Employment			Farm number				
Name	Symbol		Initial	Indirect	Net ^a	Expected coefficient sign	Initial	Indirect	Net ^a	Expected coefficient sign
Factor supply (Investments)										
Education	X ₁₁	Increase	Decrease	Decrease	Decrease	-	Decrease	Decrease	Decrease	-
Corps of Engineers	X ₂₁	Increase	Increase	Decrease	I or D	-	Increase	Decrease	I or D	-
Soil Conservation Service (PL-566)	X ₃₁	Increase	Increase	Decrease	I or D	-	Increase	Decrease	I or D	-
Agricultural Stabilization and Conservation Service (ACP)	X ₄₁	Increase	Increase	Decrease	I or D	-	Increase	Decrease	I or D	-
Farmers Home Administration (W & S)	X ₅₁	Increase	Increase	Decrease	I or D	-	Increase	Decrease	I or D	-
Crop allotments	X ₆₁	Decrease	Decrease	Decrease	Decrease	+	Decrease	Decrease	Decrease	+
Product demand										
Agricultural product price	PP ₁₁	Increase	Increase	Decrease	I or D	+ or -	Increase	Decrease	I or D	+ or -
Factor price										
Agricultural wage rate	FP ₁₁	Increase	Increase	Decrease	I or D	+	Decrease	Increase	I or D	-
Technology										
Agricultural technology	Z ₁₁	Increase	Increase	Decrease	I or D	-	Decrease	Increase	I or D	-
Shifters of firm entrepreneur supply										
Agricultural wage opportunity	W ₁₁	Increase	b	b	b	b	Decrease	Increase	I or D	-
Agricultural employment opportunity	WE ₁₁	Increase	b	b	b	b	Decrease	Increase	I or D	-
Farm operator age	WA	Increase	b	b	b	b	Decrease	Increase	I or D	+
Number of farms	N ₁	Decrease	Decrease	Increase	Decrease	+	c	c	c	c

^aThe abbreviations I and D represent increase or decrease, respectively.

^bDoes not apply since these variables are not included in the employment structural equation.

^cDoes not apply since number of farms was the dependent variable for this equation.

Table 3. Expected effect of changes in predetermined variables on manufacturing employment^a

Variable		Symbol	Direction of change for variable	Initial	Indirect	Net	Expected coefficient sign
Name							
Factor supply (Investments)							
Education		X_{11}	Increase	Increase	Increase	Increase	+
Corps of Engineers		X_{21}	Increase	Increase	Decrease	Increase or decrease	+
Soil Conservation Service (PL-566)		X_{31}	Increase	Increase	Decrease	Increase or decrease	+
Agricultural Stabilization and Conservation Service (ACP)							
		X_{41}	Increase	Increase	Decrease	Increase or decrease	+
Farmers Home Administration (W & S)		X_{51}	Increase	Increase	Decrease	Increase or decrease	+
Product demand							
Manufacturing product price		PP_{ki}	Increase	Increase	Decrease	Increase or decrease	+
Factor price							
Manufacturing wage rate		FP_{ki}	Increase	Decrease	Increase	Increase or decrease	-
Technology							
Manufacturing technology		Z_{ki}	Increase	Increase	Decrease	Increase or Decrease	-
Shifters of firm entrepreneur supply							
Manufacturing wage opportunity		W_{ki}	Increase	Decrease	Increase	Increase or decrease	-
Manufacturing employment opportunity		WE_{ki}	Increase	Decrease	Increase	Increase or decrease	-
Number of firms		N_i	Increase	Increase	Decrease	Increase	+

^aConstruction is included as a manufacturing industry in this table.

Firm Numbers

Changes in the number of manufacturing firms for the period 1958 to 1967 were obtained from data reported in the 1958 Census of Manufactures [30, State Table 7] and the 1967 Census of Manufactures [23, State Table 9]. Firm numbers are reported for each two-digit SIC industry in each county. Some industries were combined to conform to the classification of industries used in this study.

Changes in the number of farms from 1959 to 1969 for each county were obtained from the 1959 Census of Agriculture [31, County Table 1] and the 1969 Census of Agriculture [32, County Table 1]. Changes in the number of farm firms were used as both predetermined and endogenous variables. This distinction is discussed in a later section.

Factor Supplies

Changes in the supply of critical factors in a county should influence that county's labor employment. Investments that increase the supply of a given factor would be expected to cause the price of the factor to decline initially. A price decline would entice users to substitute more of the factor for other production inputs including labor. With perfectly elastic product demands and a reduced price for the critical factor, residual returns to firm operators should increase. In the absence of any substantial barriers to entry of new firms into the industry, new firms would be established, and this would increase industry output. Entrance of new firms would result in an upward shift in the demand for all factors, including labor, causing the prices of those factors having upward sloping supply functions to rise. Existing firms would also expand output. Residual returns to firm operators would subsequently fall, resulting in a cutback in factor employment. At the new

equilibrium, the quantity of labor employed would be greater or less than the initial quantity, depending on the relative sizes of the demand and supply elasticities as pointed out in the theory section. It would also depend on the elasticity of substitution of labor for the other factors whose prices varied. Labor could probably not be easily substituted for many of the natural resources considered in this analysis. Therefore, investment programs to increase the supplies of these natural resources should also increase the amount of labor required to complement industry expansion resulting from either the initial project construction phase or from users of the project.

Education investments (X_1).--Federal and state expenditures per pupil for education were considered to be exogenous to a county. Changes in these expenditures over the period 1959-1960 to 1969-1970 were included as a measure of exogenous shifts in the investment in a county's human resources. Expenditure estimates were obtained from state education agencies in Alabama [33, 34], Mississippi [35, 36], and Georgia [37, 38], and the Florida Statistical Abstract [39].

Increases in education expenditures should partially reflect an increase in the number of persons in the recipient county attaining a given educational level as well as an increase in the average productivity level of the labor force. Unless outmigration from the counties of people receiving the education occurs, an upgraded labor force should attract potential employers and eventually result in increased employment within the recipient counties.

The effect of increases in education levels or agricultural employment and farm numbers should be opposite their effect on construction

and manufacturing employment. Since agricultural labor draws heavily from the unskilled labor force it seems likely that increased educational opportunities would reduce this labor force and lead to outmigration from the more rural counties to more attractive job alternatives in urban areas. This would lead to fewer agricultural workers and probable consolidation of farms to gain operational efficiencies. Increased educational opportunity should, therefore, yield negative coefficients for agricultural employment and farm numbers and positive coefficients for construction and manufacturing employment as shown in Tables 2 and 3.

Corps of Engineers' natural resource investments (X_2).--For this variable as well as the other types of natural resource projects, total project expenditures by county over the period 1960 to 1970 were used as the independent variable. Interpretation of the estimated coefficients for these investment variables should provide insights into two components of the analysis. First, the empirical significance of the various types of natural resource investments on local employment and firm numbers can be shown, and second, the relative importance of the various natural resource investment categories in influencing employment and firm numbers can be appraised.

Investments by the Corps of Engineers in civil works and new work construction were obtained for each county from the various district offices which administer portions of the four-state area.⁸ Investments

⁸Corps of Engineer personnel providing data through personal communications were:

J. W. Dement, Chief, Engineering Division, Memphis District, U.S. Army Corps of Engineers, Memphis, Tennessee.

W. T. Moore, Chief, Engineering Division, Savannah

were measured in thousands of dollars. These investments covered projects categorized into multipurpose, navigation, flood control, beach control, and recreation projects. The major portion of expenditures was for flood control and navigation with a very small portion allocated to beach control and recreation. Due to the large amount of the investments going into flood control and navigation projects, no distinction among the above investment categories was made. Some expenditures by the Corps for construction projects along the Mississippi River could not be allocated to counties. Therefore, these investments were not included in the analysis. Investments occurred in 148 of the 375 counties comprising the four-state area.

Investments by the Corps of Engineers should also have contrasting effects on agricultural and manufacturing employment. Improved flood control would be beneficial to agricultural areas by making more land available for use. This would bring about a two-fold reaction. Both expansion of existing farms and the entrance of new farms would occur with the probable result being decreased residual returns to each firm as the price of land is bid upward. The probable consequence would

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J. L. Smith, Chief, Construction Division, New Orleans District, U.S. Army Corps of Engineers, New Orleans, Louisiana.

K. E. McLaughlin, Comptroller, Vicksburg District, U.S. Army Corps of Engineers, Vicksburg, Mississippi.

F. P. Gaines, Chief, Engineering Division, Nashville District, U.S. Army Corps of Engineers, Nashville, Tennessee.

be further expansion of the larger more established farms with the overall effect being a reduction in farm numbers. It follows that the larger farms might also operate with a smaller total labor force though a more efficient operation realized as the result of the larger farm size. The consequence would be reductions in farm numbers and agricultural employment as indicated by the coefficient sign in Table 2.

In contrast to the effect on agriculture, construction and manufacturing employment would likely increase as the result of Corps of Engineers' investments. Employment would certainly increase in the recipient area during the initial construction phase of the project. Initial effects might also be felt in manufacturing provided that local area materials were used. More importantly for manufacturing, however, would be the effect occurring during the life of any project. Improved transportation facilities, protection from flood damage, etc., would encourage the entrance of new firms and resultant employment increases. Since firm consolidation in manufacturing does not occur as readily as in agriculture, the indirect effect of decreases in firm numbers and employment is probably not large enough to offset the initial positive gains in the recipient area. A positive coefficient for construction and manufacturing employment would be expected as indicated in Table 3.

Soil Conservation Service PL-566 investments (X_3).--Construction expenditures by county from 1960 to 1970 for the Small Watershed Program were obtained from personnel in each of the four-state offices of the Soil Conservation Service.⁹ Data were tabulated from 239-B forms which

⁹Soil Conservation Service data were provided through personal communications from:

gave actual dates of construction expenditures for each project.

Investments were then allocated to each county based on project location as identified on maps prepared by the Soil Conservation Service. A total of 111 counties received these types of investments during the study period. Investments were measured in thousands of dollars.

The Small Watershed Program is designed to aid in the solution of several types of problems. Of major importance among these is the reduction in floodwater damages to cropland, residences, businesses, and protection of the health and lives of people from floods. Other potential and existing problems that this program attempts to alleviate include erosion and sediment damage, improper drainage, and irrigation needs. Recreation, fish and wildlife enhancement, and improvements in the economic and social well-being of people have also received attention. These latter categories have been given increased emphasis in recent years. PL-566 investments by the SCS which result in improvements for the local recipient areas should provide conditions that affect agricultural and manufacturing employment and farm numbers within the local areas in a manner quite similar to that of Corps of Engineers' investments. Reduction of floodwater damage to cropland should in total reduce the number of farms and agricultural employment as indicated in Table 2. Although some new farms might become established

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Florida.

the consolidation effect into larger farms to take advantage of improvements made possible by the PL-566 project should be greater.

Construction employment should increase in the recipient area during both the initial and secondary project phases and ultimately as a result of the project in a manner similar to that discussed for Corps of Engineers' investments. Also to be expected is an increase in manufacturing employment as indicated in Table 3. Increased output resulting from project expenditures should provide a base for more manufacturing employment in conjunction with increased enhancement for manufacturing firm location resulting from the reduction in floodwater damages to residences, businesses and through the effect of other firm location attributes improved by the investment project.

Agricultural Stabilization and Conservation Service ACP

investments (X_{it}).--Investments by the Agricultural Stabilization and Conservation Service constitute a joint effort by the public sector, farmers, and ranchers to share the cost of establishing needed conservation measures. These conservation programs include practices to protect, improve, and renew soil, water, woodland, and wildlife resources of private landowners. Data for the analysis were obtained from annual state ASCS reports during 1960 to 1970 for Alabama [40], Mississippi [41], and Florida [42]. Expenditure information included cash payments to farmers and allowances paid to vendors for conservation materials furnished farmers. Data for Georgia were taken directly from computer printouts.¹⁰ A total of 374 counties had participants in the ACP

¹⁰Personal communication from the Data Division, Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Program during the study period. Investments were measured in thousands of dollars.

Conservation measures which make land more available could also influence the expansion of existing farms as well as encourage new farms. The trend historically has been toward larger farms. Since this is a cost-sharing program it seems logical to expect the larger farmers to take advantage of this program opportunity and expand operations even more. The indirect effect of entrance of new farms should be more than offset by the consolidation of existing farms leading to a decrease in total agricultural employment and farm numbers. Conservation measures that remove land from production would provide a similar circumstance. This negative overall effect is indicated in Table 2.

Since this type program requires some construction activity and manufactured input which usually are purchased locally, a positive effect on construction and manufacturing industry employment would be expected as indicated in Table 3. Increased output would also be expected to result from the application of conservation measures leading to a need for more processing and support facilities which in turn should have some positive effect on manufacturing employment. Any negative feedback effect on manufacturing employment should not be large enough to affect the initial positive effect.

Farmers Home Administration investments (X_5).--Loans and grants for community water, sanitary sewer, and solid waste disposal systems were also considered to be investments that would influence employment and farm numbers in each county as indicated in Tables 2 and 3. This program provides financial assistance to communities in developing essential new public service facilities and in expanding existing

facilities. Data for these investment loans in thousands of dollars were obtained from the various state directors of the Farmers Home Administration.¹¹ A total of 278 counties received financial assistance from FHA during the study period.

Services and facilities provided by this type program are necessary before a community can expand with regard to attracting new industry and in turn services to support these industries. Communities demonstrating adequate services will likely attract new industry and thus expand employment in construction and manufacturing industries. Expansion of existing firms in the community might also occur, and this further supports the positive employment coefficient demonstrated in Table 3. This program does not specifically influence a production input used in agriculture such as land or water in the same manner as the four earlier programs. A similar negative effect on agricultural employment and farm numbers as discussed for the earlier programs would be expected. As community facilities become available and the community begins to develop its manufacturing base, job alternatives for agricultural employees and farm operators become more available. Smaller farms are soon consolidated with the displaced operators assuming other types of employment. Fewer employees are then required because of more efficient operations and the negative effect occurs.

Crop allotment (X_6).--Changes in crop allotments represent the effect of shifts in a perfectly inelastic factor supply on the number of

¹¹State Directors, Farmers Home Administration, providing data through personal communication were; S. B. Wise, Jackson, Mississippi; John N. McDuffie, Atlanta, Georgia; John A. Garrett, Montgomery, Alabama; and William Shaddick, Gainesville, Florida.

farms and employment in agriculture. A decrease in allotment acreage would be expected to increase the market price of the allotment, or of land, leading to lower residual returns to farm operators and ultimately to a reduction in the number of farm firms. As the number of farms decline aggregate demand for allotments would decline and thus lower their market prices. The magnitude of changes in the number of farm firms and consequently in agricultural employment due to a decrease in allotments would depend on farm operators' responsiveness to changes in their residual returns, the amount of allotments used in the production process, and the actual level of operator returns.

Reductions in acreage allotments between 1959 and 1969 for all allotted crops were computed for all counties having acreages of these crops. Annual reports for 1959 and 1969 from the Agricultural Stabilization and Conservation Service in Alabama [40], Mississippi [41], Georgia [43] and Florida [42] provide data on allotted crop acreages. County reductions were weighted according to total value of sales of each crop as a proportion of total value of crop and livestock sales in the county in 1959 as derived from data available in the 1959 Census of Agriculture [31]. Declines in harvested acres in each county were also computed using the same data sources that provided information on allotment reductions. The smaller of these two changes was then selected as the effective cut in allotments. Allotment reductions were not considered relevant for a county if its harvesting acreage in 1959 was less than the county's acreage allotment for the selected crop in 1969. Positive coefficients would be expected as shown in Table 2.

Product Demand

Use of a product price as an indicator of product demand is based on the assumption of perfectly elastic demand functions at the county level. Producers in both agricultural and manufacturing industries at the county level are assumed to be price takers and thus face perfectly elastic demand functions. An increase in product price would initially increase residual returns to firm entrepreneurs. This would have the effect of enticing new firms into the industry and ultimately an increase in the quantity of resources employed in the production process including labor. Also, existing firms would expand output and hence increase their demands for production factors. Increases in demand for factors with upward sloping supply functions would lead to increased factor prices and reduced returns to firm entrepreneurs. Consequently, firm numbers would decline and this would result in a reduction in labor employment. Existing firms would also reduce their output and cause reductions in resource demands. The net change in labor employment would depend on the relative magnitude of both the initial and indirect effects of these changes in output of existing firms and in the number of firms. A product price variable was not included for the construction industry since output is not easily defined in terms of a product with an established market price.

Agricultural product price (PP_1).--Changes in price indexes were computed for each of the seven major agricultural commodity groups produced in the study area using three year averages centered on 1959 price indexes [44] and 1969 price indexes [45]. These changes were weighted by the 1959 value of each commodity group as a proportion of the total

value of crops and livestock produced in each county. The resulting measure was a weighted change in product prices faced by farm producers at the county level. Value of products sold was obtained from the 1959 Census of Agriculture [31, County Table 5]. A priori specification of the net result of increases in agricultural product prices on employment is difficult. It is quite possible that increases in Agricultural product prices could lead to a reduction in agricultural employment and farm numbers due to farm consolidation. Since some agricultural operations do allow fairly easy entry, the opposite effect could occur under certain conditions.

Manufacturing product price (PP_k).--Changes in national wholesale price indexes as reported by the Bureau of Labor Statistics [46] for three-digit level (SIC) industries between 1959-61 and 1969-71 were used in computing a county product price for each two-digit level industry. For each industry, county price changes were obtained by weighting the change in the three-digit national wholesale price indexes by the 1958 value added by manufacturing for each three-digit level industry as a proportion of the total value added for the two-digit industry in the county. Data used to calculate value added for each industry were obtained from published data made available by the U.S. Bureau of the Census [30, 47].

Expected effects of product price increases in the manufacturing industries are also difficult to specify. Existing firms would be expected to expand output and new firms enter the industry as the result of a product price increase. This assumes there are no barriers to entrance. Increases in employment should occur. Output increases should ultimately cause price declines with some of the earlier

expansion being offset. With manufactured products, unlike agricultural commodities, some apparent downward inflexibilities of prices would help support in part a conclusion that the indirect effect of decreasing employment would not completely offset the direct effect leaving a positive overall effect on manufacturing employment. It does remain possible that decreased residual returns to firms as the result of entry by new firms would be substantial enough to cause an actual decline in employment. Both alternatives are indicated to demonstrate the effect of product price increases on manufacturing employment in Table 3.

Factor Price

Changes in the price of factors whose supply is assumed to be perfectly elastic would affect the net returns to firm entrepreneurs and consequently the number of firms. Indirectly, the level of labor employment would be affected. As the price of factors having perfectly elastic supply functions increased, labor as well as other production factors would be substituted for these inputs to the extent possible. This would result in an increase in the price of all factors having upward sloping supply functions. As these factor prices increased, residual returns to firm entrepreneurs would decrease and consequently the number of firms would decline. A reduction in firm numbers would decrease factor demands, resulting in a decline in factor prices. Increases in residual returns to firm entrepreneurs would entice some new firms into the industry with resultant increases in labor employment. Employment levels under new equilibrium conditions would depend on the relative magnitudes of these various changes. The more inelastic the supply function of critical factors, other than labor, the larger the price increase will

be for that factor as demand for it increases. Consequently, labor whose supply function is more elastic would be substituted for the higher priced factor with a resultant employment increase.

Agriculture wage rate (FP_L).--A proxy variable was used as the annual wage rate for agricultural employees. Total expenditures for hired farm labor in 1959 and 1969 for all farms in each county were divided by the total number of hired farm laborers working 150 days or more each year in that county to obtain an annual wage per worker. The change in this wage was then computed. These data were obtained from the 1959 and 1969 Censuses of Agriculture [31, 32]. Employment effects of increases in hired farm labor wage rates should be negative as shown in Table 2. Wage increases would result in higher factor costs to operators. This would encourage substitution of other factors for labor. Smaller farms would not be able to make sufficient substitutions and would not be able to compete with larger and more efficient farm operations. Farm numbers would then decline through consolidation and expansion of existing farms.

Manufacturing wage rate (FP_k).--Changes in average annual production worker wage rates between 1959 and 1970 for each two-digit level manufacturing industry in each county were used for manufacturing wage rate changes. Data were obtained from the 1959 and 1970 County Business Patterns for each state [48, 49]. If the two-digit level industry wage was not reported for a county due to disclosure problems, the change in average annual production worker wage for all manufacturing industries in the county was used. Increases in an industry's wage rates would be expected to result in a decrease in labor employment within the industry as

indicated by the negative coefficient sign in Table 3. Other production factors would be substituted for labor as the price paid to labor increased.

Technology

Changes in technological forces that affect agriculture and manufacturing industries should have an effect on the amount of labor employed. Similar to the other types of shifters discussed previously, technology changes would also affect factor demand, product supplies, and the number of firms. Increases in technology that were output increasing and nonlabor input decreasing would cause the quantity of products produced to increase with subsequent decreases in the use of inputs. Prices of those inputs having inelastic supply functions would decrease since demand for them would decline. Further substitution of the lower priced inputs for labor could cause a decrease in employment. If technology changes had been labor decreasing, the quantity of labor would have decreased initially. The indirect effect of these changes would be an increase in the number of firms concomitant with an increase in residual returns as a result of the change in technology. New firms would then increase the demand for all factors and reduce firm residual returns. Equilibrium quantity of labor demanded could be either smaller or larger than the initial quantity demanded depending on the degree of factor supply inelasticity, substitutability of labor for the other factors used, and the magnitude of changes in the number of firms.

Agricultural technology (Z_1).--Changes in output per man-hour in agriculture were used as indicators of changes in agricultural technology. Changes in the index of output per man-hour for six major commodity groups

in the Southeast were computed using three-year averages centered on 1959 and 1969 [50, p. 8]. These changes were then weighted by the 1959 value of each commodity group produced as a proportion of the total value of crops and livestock produced in each county obtained from the 1959 Census of Agriculture [31, County Table 5]. The resulting measure was a weighted change in labor productivity for each county. Trends in output per man-hour and advances in agricultural mechanization suggest that technology increases in agriculture are likely to be labor decreasing. A negative effect on agricultural employment should be indicated as suggested in Table 2. Similar effects would be expected on farm numbers. Technology advances should enable the operation of larger farms with resultant decreases in farm numbers.

Manufacturing technology (Z_k).--Changes in technology for each manufacturing industry were computed in a manner similar to that for agriculture. Changes in national output per man-hour indexes between 1960 and 1970 for three-digit level industries were used in computing a county technology change variable for each two-digit level industry. These indexes are published by the Federal Reserve System [51]. Changes in the national output per man-hour indexes for the three-digit level industry were weighted by the 1959 value added of each three-digit level industry as a proportion of the total value added by the two-digit level industry in the county. The same value added data used in calculating industry product price was used in the weighting procedure. Technology changes in the manufacturing industries have employment effects similar to those in agriculture. The negative effect indicated in Table 3 implies that technology changes are probably labor decreasing. A technology

variable for the construction industry was not included since output per man-hour indexes for construction were not available.

Farm Operator Supplies

Changes in farm operator supplies affect agricultural employment in various ways. Several variables used in this study are quite unique with respect to the types of shifters discussed earlier. These shifters are thought to affect farm operator supplies which in turn affect agricultural employment. Changes that increase the number of farms indirectly cause increases in the amount of products produced and factors used including labor. Ultimately, the price of factors having less than perfectly elastic supply functions would increase with concomitant decreases in the number of farms, quantity of products produced, and quantity of labor employed. Equilibrium employment levels would depend on the relative magnitudes and effects of the described changes. In general, declines in farm operator numbers should cause declines in agricultural employment.

Agricultural wage opportunity (WW_1).--Wages in industries other than agriculture represent changes in the opportunity cost to farm operators of remaining in present employment as a result of changes in wages in other employment alternatives. Initially, wage increases in employment alternatives would decrease the number of farm operators remaining in agriculture. As the larger farms realize greater residual returns some increase in farm numbers might occur. This effect should be minimal with an overall decline in farm numbers expected as indicated in Table 2. The movement to fewer, larger, and more efficient farms should then cause a negative effect on agricultural employment as indicated in Table 2.

Change in agricultural opportunity wages between 1960 and 1970 in each county was determined using data on employee wages obtained from County Business Patterns [48, 49] and the Census of Population [29]. Change in annual nonagricultural wages between 1959 and 1970 per agricultural employee in 1960 was used as the indicator of wage opportunity for agricultural employees. Changes in county unemployment levels would have provided an alternative measure for this variable.

Agricultural employment opportunity (WE_1).--Increases in employment opportunity in alternative employment situations would be expected to decrease the number of farm operators remaining in agriculture in a manner similar to that of increases in wages in employment alternatives. Changes in employment alternatives were calculated using employment data obtained from the 1960 and 1970 Censuses of Population [24, 29]. Changes in nonagricultural employment between 1960 and 1970 per agricultural employee in 1960 indicate employment opportunities for agricultural workers and farm operators.

Farm operator age (WA).--Farm operator age represents the change in the number of farmers who were 55 or more years of age during the period 1959 to 1969. This variable is intended to reflect the relative effects of potential operator retirements on the number of farms during 1959 to 1969. The greater the number of farmers who are reaching an older age, the greater should be the decline in farm numbers and employment during the entire period. This variable was calculated for each county from the 1959 Census of Agriculture [31, County Table 5] and the 1969 Census of Agriculture [32, County Table 3]. A positive coefficient sign would be expected as shown in Table 2. Declines in the number of

older farm operators would be expected to cause declines in farm numbers. Implicit in this is the assumption that farm consolidation occurs rather than operator replacement.

Manufacturing Labor Supplies

Changes in the supply of labor available to a particular manufacturing industry certainly affect employment in that industry. Shifters of labor supplies would logically cause changes in the number of firms in the industry which would in turn affect employment. Changes in the number of manufacturing firms for a given manufacturing industry were considered exogenous, however, and shifters of manufacturing industry labor supplies are discussed below as a direct effect on manufacturing industry employment.

Manufacturing wage opportunity (WW_k).--Wages in manufacturing industries other than the industry of present employment (k^{th}) represent changes in the opportunity cost to employees of remaining in present employment as a result of changes in wages in other employment alternatives. Initially, wage increases in other industries would entice employees to leave their present industry if their skills were transferable. Their present industry might bid wages upward and regain to some extent but an overall negative effect would be expected as indicated in Table 3.

Change in opportunity wages between 1960 and 1970 in each county was determined for construction and manufacturing using data on employee wages obtained from County Business Patterns [48, 49] and the Census of Population [29]. It was hypothesized that employees would not be moving into the agricultural industry because of its low average wage level. The change in annual nonagricultural wages between 1959 and 1970 per

construction worker in 1960 in each county was used to indicate the wage opportunity for construction industry employees. A similar measure was calculated per manufacturing employee in each county.

Manufacturing employment opportunity (WE_k).--Increases in employment opportunity in alternative employment industries would be expected to affect the number of employees in the given industry in a manner similar to that of increases in wages in other industries. Changes in alternative manufacturing employment were calculated for each county using employment data obtained from the 1960 and 1970 Census of Population [24, 29] by computing the change in all employment other than agriculture and industry of present employment per worker in industry of present employment. Increases in employment opportunity in other manufacturing industries should decrease employment in the industry of present employment as shown in Table 3. Growth in industries that are complementary in nature would be expected to positively affect employment in each other.

Number of manufacturing firms (N_k).--Changes in the number of manufacturing firms were used as predetermined variables in the construction and manufacturing models. An increase in the number of firms in general would be expected to bring about an increase in employment. Some cases would exist where intrafirm expansion could bring about an employment increase while firm numbers were declining. In general, a positive sign should be expected for this coefficient as shown in Table 3. Data sources for firm numbers were outlined earlier.

CHAPTER IV

ANALYSIS OF RESULTS

Parameter estimates in equations identical to those presented in Chapter III were made for agriculture, construction, and the various manufacturing industries. Equations (3.9.1.1) and (3.9.1.2) were used for agriculture. Equation (3.9.2.1) was used for construction and equation (3.9.k.1) was used for the manufacturing industries. All equations were estimated for each of the three groupings of counties. Counties were excluded if no employment was reported in both 1960 and 1970. In this chapter a comparison is made of parameter estimates obtained from estimating the relationships for each of the three groups. Effects of the predetermined variables on employment in each industry and farm firm numbers for agriculture are discussed. General comparisons of the results obtained for all three groups are made.

Agriculture

Tables 4 through 6 contain the parameter estimates for the two-equation models used for agriculture. Each table presents three equations for one of the three groupings of counties. Table 4 presents the results for all counties, Table 5 the results for the urban counties and Table 6 the results for the nonurban counties. In the following discussion each agricultural equation in the tables is not referred to separately as the parameter estimates are discussed. Each parameter and

Table 4. Structural form and reduced form coefficients for change in agricultural employment (E_1) and number of farm firms (N_1), all counties, 1960 to 1970.

Predetermined variables ^a	Endogenous variables ^a		
	Structural form coefficients		Derived reduced form coefficients
	Agricultural employment (E_1) ^b	Number of farm firms (N_1) ^c	Agricultural employment (E_1)
Constant	-8.69	14.63	3.03
Education (X_1)	-.1476 (.2906)	.2055* (.1073)	.0169
CE (X_2)	-.0033 (.0038)	-.0005 (.0014)	-.0037
PL-566 (X_3)	-.0741 (.1003)	.0314 (.0307)	-.0489
ACP (X_4)	-.5671 (.0947)	-.3882*** (.0278)	-.8779
FHA (X_5)	-.0527 (.0309)	-.0596*** (.0105)	-.1004
Allotment (X_6)	.1577 (.0747)	.0763*** (.0268)	.2187
Product price (PP_1)	2.4475 (3.9030)	7.4334*** (1.3790)	8.3983
Wages (FP_1)	-.0070 (.0093)	.0031 (.0030)	-.0045
Technology (Z_1)	1.9176 (1.4180)	-1.0211* (.5400)	1.1002
Wage opportunity (WW_1)	--	-1.1679 (2.6060)	-.9350
Employment opportunity (WE_1)	--	-.4192 (1.0110)	-.3356
Farm operator age (WA)	--	1.6046*** (.0736)	1.2846

Table 4 (Continued)

Predetermined variables ^a	Endogenous variables ^a		
	Structural form coefficients		Derived reduced form coefficients
	Agricultural employment (E_1) ^b	Number of farm firms (N_1) ^c	Agricultural employment (E_1)
Number of farms (N_1)	.8006 (.1251)	--	--
Dummy (GRP)	297.4100 (58.2700)	29.5200 (23.4800)	321.0400
R^2	--	.82	--
$\bar{R}^2$	--	.81	--

^aComplete variable definitions can be found in Chapter III.

^bChange in agricultural employment was estimated with two-stage least squares. Figures in parentheses for this equation are asymptotic standard errors. Levels of significance are not indicated since they are approximations.

^cChange in number of farm firms was estimated by ordinary least squares with figures in parentheses indicating standard errors. Since this equation is just-identified and contains all predetermined variables the structural coefficients are identical to the derived reduced form coefficients.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

Table 5. Structural form and reduced form coefficients for change in agricultural employment (E_1) and number of farm firms (N_1), urban counties, 1960 to 1970

Predetermined variables ^a	Endogenous variables ^a		
	Structural form coefficients		Derived reduced form coefficients
	Agricultural employment (E_1) ^b	Number of farm firms (N_1) ^c	Agricultural employment (E_1)
Constant	268.80	-78.21	263.30
Education (X_1)	.8879 (.8316)	.3991** (.1619)	.9159
CE (X_2)	-.0058 (.0104)	.0018 (.0021)	-.0057
PL-566 (X_3)	.3388 (.2186)	.0804* (.0433)	.3444
ACP (X_4)	-.8410 (.2107)	-.2482*** (.0427)	-.8584
FHA (X_5)	-.0682 (.0595)	-.0311** (.0121)	-.0703
Allotment (X_6)	.1843 (.3383)	.0580 (.0688)	.1884
Product Price (PP_1)	-14.4830 (9.5980)	4.9352** (1.9490)	-14.1364
Wages (FP_1)	.0343 (.0427)	.0131 (.0088)	.0352
Technology (Z_1)	-1.1216 (3.2520)	-.1356 (.6920)	-1.2014
Wage opportunity (WW_1)	--	-.3720 (2.5290)	-.0261
Employment opportunity (WE_1)	--	.1350 (.7820)	.0095
Farm operator age (WA)	--	1.9111*** (.0965)	.1342

Table 5 (Continued)

Predetermined variables ^a	Endogenous variables ^a		
	Structural form coefficients		Derived reduced form coefficients
	Agricultural employment (E_1) ^b	Number of farm firms (N_1) ^c	Agricultural employment (E_1)
Number of farms (N_1)	.0702 (.2503)	--	--
R^2	--	.93	--
$\tilde{R}^2$	--	.92	--

^aComplete variable definitions can be found in Chapter III.

^bChange in agricultural employment was estimated with two-stage least squares. Figures in parentheses for this equation are asymptotic standard errors. Levels of significance are not indicated since they are approximations.

^cChange in number of farm firms was estimated by ordinary least squares with figures in parentheses indicating standard errors. Since this equation is just-identified and contains all predetermined variables the structural coefficients are identical to the derived reduced form coefficients.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

Table 6. Structural form and reduced form coefficients for change in agricultural employment (E_1) and number of farm firms (N_1), nonurban counties, 1960 to 1970

Predetermined variables ^a	Endogenous variables ^a		
	Structural form coefficients		Derived reduced form coefficients
	Agricultural employment (E_1) ^b	Number of farm firms (N_1) ^c	Agricultural employment (E_1)
Constant	-470.60	58.59	-390.70
Education (X_1)	-.3154 (.2515)	.1246 (.1312)	-.1454
CE (X_2)	.0007 (.0034)	-.0021 (.0017)	-.0022
PL-566 (X_3)	-.1474 (.0959)	-.0109 (.0481)	-.1623
ACP (X_4)	-.2659 (.0940)	-.4153*** (.0352)	-.8324
FHA (X_5)	.0456 (.0334)	-.0796*** (.0143)	-.0630
Allotment (X_6)	.0821 (.0595)	.0779*** (.0290)	.1884
Product price (PP_1)	4.2840 (3.5910)	8.5897*** (1.7430)	16.0029
Wages (FP_1)	-.0058 (.0073)	.0020 (.0037)	-.0030
Technology (Z_1)	7.0522 (1.4980)	-1.4802* (.7969)	5.0328
Wage opportunity (WW_1)	--	.1759 (4.1390)	.2400
Employment opportunity (WE_1)	--	9.0983* (4.7030)	12.4128
Farm operator age (WA)	--	1.4027*** (.0947)	1.9137

Table 6 (Continued)

Predetermined variables ^a	Endogenous variables ^a		
	Structural form coefficients		Derived reduced form coefficients
	Agricultural employment (E_1) ^b	Number of farm firms (N_1) ^c	Agricultural employment (E_1)
Number of farms (N_1)	1.3643 (.1322)	--	--
R^2	--	.80	--
$\bar{R}^2$	--	.80	--

^aComplete variable definitions can be found in Chapter III.

^bChange in agricultural employment was estimated with two-stage least squares. Figures in parentheses for this equation are asymptotic standard errors. Levels of significance are not indicated since they are approximations.

^cChange in number of farm firms was estimated by ordinary least squares with figures in parentheses indicating standard errors. Since this equation is just-identified and contains all predetermined variables the structural coefficients are identical to the derived reduced form coefficients.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

the comparisons that are made can be found in the three tables. Means and standard deviations of each variable are given in Appendix B.

Type of Equation

Tables 4 through 6 contain both structural equations and derived reduced form equations. Each structural equation for changes in employment was estimated by two-stage least squares. The equation is over-identified in each model and contains two endogenous variables. Coefficients of these equations can be interpreted as the direct effect on changes in agricultural employment of a one-unit change in the pre-determined variable. Figures in parentheses are asymptotic standard errors. These can be examined in relation to each coefficient to provide an approximation of the statistical reliability for each coefficient using standard normal test procedures.

The equation for changes in the number of farm firms was estimated by ordinary least squares. It is one of the two structural equations of each two-equation model. The equation contains only one endogenous variable (change in the number of farm firms) and all of the predetermined variables in the model.

Each table also contains a derived reduced form equation for employment changes. Reduced form equations express an endogenous variable as a function of all exogenous variables in the model. Coefficients in this equation can be interpreted as the partial derivative of the endogenous variable with respect to any predetermined variable with all other predetermined variables held constant at their mean values. This coefficient indicates the total effect of a change in the endogenous variable after taking into account the interdependencies among all current predetermined variables. This coefficient can be

referred to as a multiplier in contrast to a structural coefficient which indicates only a direct effect. For this particular model the structural form equation and reduced form equation for changes in the number of farm firms are identical. The structural equation contains all predetermined variables in the model expressed as a function of changes in the number of farms. This is also the reduced form equation of the model by definition.

Endogenous Variables

Changes in agricultural employment and in the number of farm firms from 1960 to 1970 represented the two endogenous variables in the agricultural equations. The trend in agricultural employment during this time period was generally downward. Although some counties did experience increases the average change was negative. The urban counties experienced the smallest average decline per county in agricultural employment while the nonurban counties had the largest average decline (Appendix B, Table 18). Urban counties had fewer agricultural employees and had already experienced larger declines in some earlier time period. Employment decline in the urban counties averaged slightly less than one-half the decline in the nonurban group. Average decline for all counties was approximately twice that of all urban counties.

The number of farm firms per county also declined for each of the three groups with the magnitude of the declines for each group having the same ordering as employment declines. Relative differences were not as large as experienced in employment. Large variation among counties was indicated for both farm number changes and agricultural employment changes (Appendix B, Tables 18 and 19).

A decline in farm numbers would be expected to cause a decrease in the number of agricultural employees. Fewer farms would cause a decline in farm operators and decrease employment. Larger and more efficient farms should also require fewer employees. This relationship was supported without exception by positive coefficients for changes in the number of farm firms when this variable was included in the employment change equation. Standard errors for this coefficient were relatively small in relation to the coefficient for both the all county group and nonurban group. The largest effect of a decrease in one farm firm on agricultural employment occurred for the nonurban group of counties while the smallest effect was indicated for the urban group. Since the structural form equation for changes in the number of farm firms was estimated by ordinary least squares the coefficient of determination (R^2) becomes a valid measure of the proportion of total variation explained by the predetermined variables in the system. The exogenous variables explained 80 percent of the total variation in farm numbers in the nonurban county group, 82 percent using all counties, and 93 percent using urban counties. Examination of corrected R^2 's showed very little decline in explanatory power when the results were adjusted for degrees of freedom.

While explanatory power was high for all groups a difference existed among the various groups of counties with respect to the statistical significance of the predetermined variables. Some of the variables that were important for one group of counties were not important for other groups. Multicollinearity was never a serious problem. Very few simple correlations among the independent variables exceeded an absolute value of .5 and in no cases were these coefficients extremely large. Identification of the variables in which the simple correlation

coefficients exceeded .5 will be made in later sections when each independent variable is discussed.

Exogenous Shifters

All predetermined variables included in Tables 4 through 6 were discussed in Chapter III. Each estimated coefficient reflects the effect of the shifter it represents according to the type of equation in which the coefficient is found.

Education investments.--Changes in per capita education expenditures did not appear to be a very important variable affecting agricultural employment changes. Negative coefficients were found for all counties and the nonurban group of counties. The coefficients indicate that a one dollar increase in per pupil education expenditures was accompanied by changes in agricultural employment of the magnitude of the estimate. Changes in per pupil expenditures were smaller for the two groups having negative coefficients than for the urban group (Appendix C, Table 20). The urban group indicated a positive effect from education expenditures. A more skilled work force resulting from higher education levels would be expected to migrate to urban areas to realize their employment potential. This migration effect is supported by the negative coefficients for the nonurban counties. It appears possible that the migration effect was large enough to support a positive coefficient for the urban group. Education expenditures appeared most important in the nonurban counties upon examination of the standard errors of each coefficient.

Somewhat different results were obtained for changes in the number of farm firms. Increases in per capita education expenditures

were significantly associated with increases in farm numbers for both the urban group of counties and the group consisting of all counties while a positive but nonsignificant coefficient was experienced in the nonurban group of counties. The opposite relationship was expected. Increases in per pupil education expenditures would be expected to enable farm operators to attain more skills and take advantage of other employment alternatives in a given area. This would be particularly true with operators of smaller and more marginal farms. The strong positive relationship for the urban counties suggests one possible effect that may be occurring. Higher educational expenditures in the urban counties coupled with higher incomes may encourage an increase in the number of small and part-time farms. This could occur even though the total number of farms might decline for a given area.

Reduced form coefficient signs and magnitudes indicate the total effect on employment as a result of education expenditures. The effect was positive for all counties and for the urban counties group. For the nonurban group where the direct negative effect on employment was largest and the positive effect on farm numbers was small the total effect was negative.

A correlation coefficient of $-.50$ between changes in per pupil education expenditures and technology change was noted in the urban group of counties. This must represent some form of spurious correlation. Increased technology levels would normally be associated with increases in educational skills.

Corps of Engineers' investments.--Investments by the Corps of Engineers demonstrated a negative effect on agricultural employment change for all groups except the nonurban group. A major portion of

investments by the Corps in the four-state study area was for flood control. Effective flood control should make more land available for agricultural use. Expansion of existing farms to benefit from this should enable more efficient labor saving operations with resultant declines in agricultural employment. Displacement of existing farms by expansion would also contribute to employment declines. It appears that this occurred in the two groups having negative coefficients. Any employment increase due to new farms in the recipient area was offset by reduction in employment as the result of farm expansion. The standard error for the positive coefficient associated with the nonurban group was quite large. Average investment in the nonurban counties was approximately one-half that in the urban counties.

The effect of a one thousand dollar change in investments on farm numbers was not significant for any of the three groups. Negative effects occurred for all counties and the nonurban group. Fewer farms would be expected if existing farms expand to take advantage of more flood protected land.

Examination of the geographical pattern of Corps of Engineers' investments gives further indication as to why positive coefficients occurred for employment in the nonurban group and for farm number changes in the urban group. A large proportion of these investments occurred in the delta area of Mississippi and in an area in east-central Alabama which are predominately nonurban areas. These areas have traditionally been areas where large numbers of small farms were in existence. Flood protection provided by Corps of Engineers' projects could have made new land available which was suited for mechanized agricultural use. This undoubtedly created a movement to larger farms through both the effect

of new farms and consolidation of the smaller farms into larger units. Increased agricultural activity as a result of the various project investments could have easily attributed to a fewer number of farms and larger number of agricultural employees in these areas as suggested by the coefficient signs. The standard errors for this variable given in Appendix B, Table 20, point out the wide variation of these investments among the counties in each group.

Examination of the reduced form coefficients indicate that the total effect on agricultural employment was negative in all three areas as expected. This total effect takes into consideration the direct effect of the investments on agricultural employment and the indirect effect as felt through changes in the number of farms.

Small Watershed Program investments.--Investments by the Soil Conservation Service in the Public Law 566 Small Watershed Program yielded average investment levels per county that were fairly uniform in all three county groups (Appendix B, Table 20). This program also exhibited the lowest average level of investment per county of any of the land or water related investments. The nonurban and all counties groups both exhibited negative effects on employment for each thousand dollars of investment. Employment effects of this investment program were identical to those of Corps of Engineers' investments. Negative effects for these two groups indicate that farm expansion may be occurring in these areas with a concurrent reduction in agricultural employment. Increases in output as the result of this expansion may then explain the positive effect in the urban area where more processing employment and agricultural services employment becomes required. The major portion of PL-566 investments in Florida occurred along the lower

West coast, Central Florida, the area immediately above Lake Okeechobee and in extreme West Florida where the areas of greatest growth have occurred during the past decade. These areas contain primarily urban counties. Similar observations on project location, but to a smaller degree, could be made about the remaining urban counties. This may have influenced the positive coefficient. As with Corps of Engineers investments the standard deviations for each group in the Small Watershed investment category point out the wide differences that exist on a county to county basis.

Positive coefficients were observed in the farm numbers equation for coefficients in the urban group and with all counties. The urban group coefficient demonstrated low statistical significance. Since one of the major stated purposes of this investment program is to prevent floodwater damage, it appears possible that previously flood-prone land became available for new farms in these groups. Declines in farm numbers occurred in the nonurban group. Farm expansion in this group may have offset any response from new farms as the result of the investment.

The total effect on employment as demonstrated by the reduced form coefficients was similar in sign to the direct effect in all cases. That is, the effect on agricultural employment of PL-566 investments as felt through changes in the number of farms was not sufficient to influence a sign change from the direct effect.

Small Watershed Program investments are similar to Corps of Engineers investments in that they are somewhat long term in nature although possibly not as long as the average Corps investment. Some effects of flood control structures and channelization projects may not yet be measurable. Some of the investments considered during the latter

part of the study period represented the beginning of certain projects. Only the effects of the construction phase may have been measured. These effects would be felt in other sectors such as construction. Since investments in the actual construction phase of any project began only as late as 1958 in the study area it is likely that some effects on agricultural employment and farm numbers had not occurred.

Agricultural Conservation Program investments.--Program investments in the Agricultural Conservation Program provided the most uniform coverage over the four-state area of any of the investment programs analyzed. Only one county did not receive an investment and the average investment per county did not vary to a large degree among the three groups. Large levels of county variation were noted.

All three groups demonstrated a negative effect on changes in employment as expected. Each group indicated very low standard errors when compared to the estimated coefficients. The negative effect on agricultural employment of a one thousand dollar increase in ACP program investments thus seemed quite important. Since this is a cost sharing program with farmers and is intended to introduce various conservation measures the negative effect on employment is logical in that measures taken with regard to land stabilization and resource improvement may have enabled the use of labor saving production practices. In some cases this program would remove land from production in further support of the negative effect.

The effect on farm numbers was also negative in each group with all groups demonstrating a high level of significance. This supports the hypothesis that larger farms with the more responsive operators have taken advantage of the cost sharing program to improve their

production practices. This may have enabled these operators to expand operations and consolidate smaller units into their own operations since the marginal units are not as likely to be able to benefit from the cost sharing program. The total effect on employment is given by the reduced form coefficients. Since all coefficients were negative the total employment effect represents a larger negative effect than either the direct investment effect or the effect as felt through reductions in farm numbers.

The importance of this variable is also indicated by its correlation with changes in the number of farms and alternative wage opportunities. Correlation with farm number change in the employment equation was $-.68$ for all counties, $-.64$ for the urban group, and $-.69$ for the nonurban group of counties. Correlation with alternative wage opportunities was $-.56$ for the nonurban group.

Farmers Home Administration investments.--Investments by the Farmers Home Administration represented a somewhat different type of investment than those discussed previously. Those discussed earlier represented actual construction expenditures or payments made that were spent in the year of allocation. Investments by the Farmers Home Administration for community water and sewer programs and recreational facilities represented loans and grants made during the time period under study and included additional grants for the projects made by other federal agencies. It is possible that some expenditures of project loans and grants made during the latter segments of the time period had not actually occurred. Data sources were inadequate to determine those expenditures.

Loans and grants made during this time period resulted in negative employment effects for all counties and the urban group. The size of the standard error of the coefficient for the all counties group indicated some importance for this variable. Investments in this program were fairly widespread over the four-state region with Mississippi receiving a large portion of the larger loans and grants particularly throughout the upper and central portions of the state. Alabama received heavy coverage with many of the grants being smaller in magnitude than those received in Mississippi. Coverage in Georgia and Florida was more isolated than in Mississippi and Alabama although most projects were larger when compared to those in Alabama. Some variation was detected among counties in this investment category. Heavy coverage in the non-urban counties might explain the positive coefficients demonstrated for this group. Availability of community water and sewage facilities could have influenced the location of agricultural related firms other than farms and thus agricultural employment.

A high level of association was determined for changes in the number of farms in all areas. Employment effects were negative for each group. Community improvement through water and sewer facilities may have caused some movement of farm operators from the farm to the communities and other employment alternatives. These alternatives may have developed because of improved community service facilities. The effect on employment of farm number changes in the nonurban group was large enough to cause a total negative employment effect. The other groups had negative effects both directly and indirectly. Since both this program and the Agricultural Conservation Program are focused especially on agricultural areas and rural communities, it appears

likely that the general downward trend in agricultural employment and farm numbers played an important role in causing the large number of negative effects for these two investment programs. There was some negative correlation between farm number changes and Farmers Home Administration loans and grants. The nonurban group had a correlation coefficient of $-.56$.

Crop allotment.--The effect of allotment reductions on agricultural employment was as expected as indicated by the positive coefficients in each of the three groups of counties. Positive coefficients for this variable indicate movement in the same direction since both the dependent variables and allotment reductions moved in a general downward trend. A small standard error was associated with the coefficients for all counties and for the nonurban group. This indicated some importance for allotment reductions in explaining employment decreases.

Florida experienced large reductions in allotted acres of cotton, tobacco, and peanuts during the study period. Alabama experienced major reductions in peanut allotments while Georgia went through a period where major declines were felt primarily in tobacco and cotton. Mississippi experienced major declines in cotton allotments. Since these crops use large amounts of labor a negative employment effect is expected from allotment reductions. Some counties suffered allotment declines in excess of 4,000 acres. Large variations in allotment reductions among counties were observed as indicated in Appendix B, Table 20.

Positive coefficients were also experienced for the effect of allotment reductions on the number of farms. A high level of association was observed for all counties with the nonurban group demonstrating a slightly lower level of association. This marked a consistent pattern

of behavior since these groups are heavily weighted with nonurban counties where the major proportion of allotment reductions occurred. It becomes evident that reductions in allotments increased their market value leading to lower operator returns. The estimated coefficients then indicate that operator responsiveness has been in some cases to exit from agriculture due to the lower returns and the inability to secure allotments. Those farms most responsive to allotment reductions were most likely the marginal units and those having large acreages of allotted crops experiencing a decline. Consequently, operator responsiveness to exit from farming as a result of allotment reductions complemented the direct effect of these reductions on agricultural employment. The total negative effect on employment as the result of allotment declines is thus demonstrated in the reduced form coefficients to be greater than the initial direct effect. This added reduction in employment is due to the effect of the reduction in farm numbers.

Agricultural product price.--Changes in product demand as measured by changes in the index of product prices did appear to be important in explaining employment changes. The nonurban counties and the group containing all counties demonstrated positive effects on employment as the result of increases in product prices. Increases in prices appear to have caused increases in product output with resultant increases in agricultural employment. Price effects for the urban group were negative. Agricultural employment would be expected to respond differently in the nonurban areas where it is more responsive to changes in product demand.

Product price effects on farm numbers were positive in all three groups. Their effect on farm numbers seemed to be very important due to

the high degree of significance of the coefficients. As product prices have increased it appears that the effect of new farms has outweighed any consolidation effect that would reduce farm numbers. The importance of product demand points out the responsiveness of agriculture to product price changes.

Product price changes are probably more important to small marginal farms because of the small volume of products sold. This might explain the increase in farm numbers rather than a decrease as one might expect through farm consolidation. The total effect on employment determined by the reduced form equation showed no directional changes although the positive effect became much larger for all counties and the nonurban group of counties.

Three of the seven commodity groups used to derive product price indexes showed a decline in the decade under study. Field crops, fruits and nuts, and poultry and poultry products showed declines while vegetables, forest products, dairy products, and livestock and livestock products experienced fairly substantial increases. The derived price index using the seven commodities demonstrated an average increase for all three groups with the urban counties demonstrating the largest price increase (Appendix B, Table 21).

Agricultural wage rate.--Changes in factor prices as demonstrated by increases in the hired wage rate did not appear important in influencing employment changes. Wage increases did appear to cause employment increases in the urban counties. Higher wage rates were associated with employment declines in the other two groups. This indicates some substitution possibly occurred for the higher priced labor input.

Mechanization is the normal substitute for labor employment in agriculture. More mechanization is also normally associated with increases in farm size. Wage rate increases would then be expected to cause declines in farm numbers. This particular circumstance was not indicated in the farm number equation as was expected. Wage rate coefficients were positive although no levels of acceptable significance were indicated. Hired wage rate increases might have encouraged enough entrepreneurs to enter farming to offset any consolidation effect occurring as a result of higher costs. This effect should be quite minimal. The total effect on employment after consideration of both the direct wage increase effect on employment and the effect through farm number changes was quite similar to the initial direct employment effect. Substantial amounts of variation were noted among counties for changes in hired wage rates.

Agricultural technology.--Output per man-hour increases for agriculture appeared to increase agricultural employment for all counties and the nonurban group. These effects seemed important upon examination of the standard errors for these two coefficients. Technology increases apparently were responsible for the use of more labor employment. This may have resulted from large output increases which in turn may have resulted in agricultural employment increases in those agricultural industries servicing the farms. Many commodities grown in the four-state study area are labor intensive. Technology increases in these commodities could have easily been responsible for increases in agricultural employment.

A somewhat different pattern emerged with respect to farm number changes and output per man-hour. Technology advancements caused a decline

in farm numbers for all three groups with low significance levels associated with all counties and the nonurban counties. It was anticipated that output per man-hour increases would reduce farm numbers through two effects. One is the ability of larger farms to take advantage of technological innovations and both increase output and farm size and the second, given that the demand for agricultural commodities is inelastic, output increases by the larger producers may affect immediate prices to such degree that smaller farms are forced to consolidate.

The total effect on employment after consideration of the farm number changes did not alter the direct technology effect. This total effect on employment further substantiates the earlier observation that any reductions of on-farm employment due to technology are more than offset by increases in on-farm and off-farm agricultural employment required to handle increased output in certain commodities.

Changes in output per man-hour among the various commodity groupings varied substantially. Those representing livestock and livestock products experienced the largest increases. Output indexes for all livestock and livestock products, dairy, and poultry doubled in the ten-year period studied. All field crops indicated increases of approximately 50 percent while increases for vegetables and fruits and nuts were very small. Consequently, the value of each county's major commodities demonstrated major influence on the index for that county. Average change for all three groups was fairly uniform. Variation among counties within each group was also fairly small.

Agricultural wage opportunity.--Increases in the opportunity cost of remaining as a farm operator should influence operators making a low return on their farming investment to seek a higher wage

alternative. Changes in nonagricultural wages did produce this result for all groups except the nonurban group although the effect on farm numbers of this change did seem important. The positive effect for the nonurban group may be explained by the relative lack of alternative employment opportunities in the nonurban areas. Average increases in opportunity wages were fairly consistent for all groups with changes in the nonurban group the smallest. The total effect on agricultural employment as felt through changes in the number of farm firms was similar to the effect on farm numbers.

Agricultural employment opportunity.--Changes in nonagricultural employment opportunities established much the same pattern as wage opportunities in affecting farm numbers and employment. Negative effects on farm numbers were observed only for the group containing all counties. The nonurban group of counties did indicate a low level of significance.

Off-farm employment opportunities were most available in the urban counties (Appendix B, Table 25) where an increase in off-farm employment suggested that an increase in farm numbers would occur. This may be reflected from an increase in part-time farmers and the increasing availability of part-time jobs for marginal operators which prohibited full exit from farming. The nonurban area demonstrated the lowest average increase in off-farm employment opportunities yet indicated that an increase in farm numbers occurred as the result of the employment opportunities. Consideration of the effect of employment opportunities on agricultural employment yielded the same directional effect in each group as was determined for changes in the number of farms.

Farm operator age.--Changes in the age of farm operators was highly associated with changes in the number of farms. Reductions in the number of operators who were 55 years of age and older occurred in each grouping of counties (Appendix B, Table 25). Decreases in the number of farms as the result of decreases in the number of older farm operators give further support to the observation that many farms are marginal. Farm consolidation is occurring rather than each older operator through retirement or death being replaced with another operator on a one-to-one basis. The total effect on agricultural employment is the same. Coefficients for each group in the reduced form equation indicated that reductions in the number of older operators reduced total agricultural employment through farm number reductions.

Group differences.--A zero-one intercept shifter was included in the group consisting of all counties to determine if differences existed between the urban and nonurban counties within the groupings. The non-urban group was used as the base group. Group differences did not appear to be very important in the farm number equation. Differences between the urban and nonurban counties did exist for changes in agricultural employment since the coefficient for this variable was approximately five times the magnitude of the standard error.

Construction

Parameter estimates in each construction employment equation for each of the three groups are given in Table 7. This equation is identical in theoretical construction to equation (3.9.2.1) and differs from those used for agriculture and manufacturing in terms of included variables. These equations were estimated by ordinary least squares.

Table 7. Regression equations for construction employment change (E_2) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	-279.60	-240.70	127.10
Education (X_1)	.9453* (.5175)	1.1809 (1.6510)	-.3252*** (.1102)
CE (X_2)	.0427*** (.0074)	.1426*** (.0251)	.0002 (.0015)
PL-566 (X_3)	-.2124 (.1932)	-.4362 (.5501)	-.0271 (.0419)
ACP (X_4)	-.2487* (.1306)	-.9751** (.4399)	.0420 (.0270)
FHA (X_5)	-.0200 (.0527)	-.0328 (.1427)	-.0297** (.0119)
Wages (FP_2)	.0833** (.0332)	.2725** (.1198)	.2756*** (.0066)
Wage opportunity (WW_2)	-11.6780*** (4.1070)	-67.7790** (31.8000)	-2.4612*** (.7480)
Employment opportunity (WE_2)	29.9510** (12.2500)	63.9780*** (5.7870)	4.2331* (2.4340)
Dummy (GRP)	469.8900*** (113.6000)	--	--
R^2	.23	.45	.13
$\bar{R}^2$	.21	.39	.10
Number of observations ^c	373	90	283

^aStandard errors are in parentheses.

^bComplete variable definition can be found in Chapter III.

^cCounties were excluded if no employment was reported.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

Dependent Variable

The change in the number of construction employees in each county between 1960 and 1970 was used as the dependent variable. Changes in construction employment demonstrated the largest average increases in the urban group. Construction employment increase in the nonurban counties was about one-eighth the size of the increase in the urban counties. Variation among counties within groups was large as indicated by the standard deviations shown in Appendix B, Table 18.

The amount of explained variation was not particularly high for construction employment. The urban counties exhibited the largest amount of variation explained (45 percent). Corrected coefficients of determination were not substantially different.

Exogenous Shifters

Lack of data prevented the use of the product price, technology, and number of firms variables in the construction equation. These variables were fairly important in agriculture and some of the manufacturing equations discussed later. Their omission probably contributed to the low percentages of total variation explained. These three variables should have been very important in the construction industry during the past decade.

Education investments.--Changes in per pupil education expenditures demonstrated significance for the all county group and the non-urban group while also exhibiting opposite signs. The positive effect shown for the urban group and all county group is an indication that a higher skilled work force is contributing to the construction industry. This would occur through the use of more skilled employees within the

industry as well as through growth in other industries that the construction industry serves. Negative effects for the nonurban counties support the hypothesis offered for agriculture that education expenditures influence outmigration for the nonurban counties with the resultant decrease in construction employment.

Corps of Engineers' investments.--Investments by the Corps of Engineers should be very significant in stimulating construction employment in a given area due to the large size of many projects undertaken. Large levels of significance were noted for the urban counties and the all counties group. Positive effects were indicated. This positive effect would be the result of both the initial construction phase and the construction activity resulting from project utilization. The non-urban counties experienced the lowest average investment levels. Much construction activity of the type used for these types of investments is centered in urban areas although the actual work may be done in a non-urban county with employment reported in the urban area. These two factors contribute to the nonsignificance of the nonurban county coefficient.

Small Watershed Program investments.--Project investments by the Soil Conservation Service in flood control structures and water movement controls should also increase construction employment during project construction. However, a negative effect was demonstrated for each of the three groups. Investments in this program are typically much smaller with lower levels of investment (Appendix B, Table 20) than those made by the Corps of Engineers. It may be more efficient for contractors outside the project area to perform the construction activity with a

commuting work force rather than the employment of local workers. Employment of this nature would not be reported in the county where the project was located. Any secondary construction employment generated in the local project area as the result of the initial project expenditure was either of minimal importance or not yet experienced during the study period. Some knowledge of project expenditures in Florida indicate that use of contractors outside the project area occurred.

Agricultural Conservation Program investments.--This program includes conservation practices such as planting permanent land cover, trees and other similar land stabilization measures as well as land leveling, reservoir construction, drainageways, pipelines, terracing and the installment of sediment control structures. Since it is done on a cost share basis the participating land owners and farm operators probably are able to implement some of the practices using their own equipment. Larger measures would undoubtedly require the use of the heavy construction industry.

The indicated employment effects of this program on construction were negative for both the all county and urban county groups with low levels of significance indicated. Since this program operates on a relatively small project basis it appears likely that any contract work done is performed by contractors based outside the county of project implementation. Larger farm operators with special equipment also do custom construction work. No increases in construction employment would be felt if this occurs.

Farmers Home Administration investments.--Local water and sewer development projects should also be expected to create employment in the

construction industry. However, a negative impact was demonstrated for all three groups with the nonurban group indicating some significance. Since most of these projects are located in rural communities, the same comments about outside contractors must be made. The initial construction employment impact is not felt in the county or community receiving the sewer or water system. Any economic growth or development generated in the system was not substantial or the time period was too short to capture the effects.

Construction wage rate.--Wage increases in any given industry represent an increase in factor prices to that industry and would be expected to decrease employment. This would occur only if other factors could be substituted for labor. Wage increases in the construction industry were very important in positively affecting employment as demonstrated by high significance levels for all three county groups. Large amounts of labor used in construction activity coupled with the apparent inability to substitute other production factors for labor are two important reasons why a positive effect was demonstrated.

Labor could also be a critical factor in the construction industry. With a downward sloping demand function and an upward sloping supply function, a shift in demand for construction labor would result in increased wages and greater employment.

Construction wage opportunity.--Increases in opportunity wages were highly significant with the negative sign as expected in all three groups. It is apparent that the opportunity cost of remaining employed in the construction sector became quite large for many workers who transferred their skills to other industries to obtain a higher wage.

Average change in nonagricultural wages per construction worker was fairly consistent except for the urban counties where the average was slightly less than one-half that of the other two groups. A correlation coefficient of $-.54$ was noticed between wage opportunity and the dummy variable for group differences.

Construction employment opportunity.--Initial a priori expectations indicate that employment opportunities in alternative industries would decrease employment in any given industry. This did not occur in construction where all three groups demonstrated a significant positive effect on construction employment from increases in alternative employment opportunities. All groups demonstrated levels of significance with the urban counties demonstrating the highest. This positive effect again points out the complementary effect of this industry. That is, as the economy of any area expands through the influence of any sector, accompanying expansion must be felt through the construction sector. Increases in employment opportunities thus require increases in construction employment. Average values for these variables were fairly consistent in all three groups.

Group differences.--Differences between the urban and nonurban counties for the all county group were indicated with a high significance level. This variable indicates a much higher level of construction activity for the urban counties.

Nondurable Manufacturing

Analysis of the equation used for manufacturing pointed out several distinctive patterns and differences between the nondurable and

durable manufacturing industries. Because of these differences discussion of the manufacturing results is broken into two sections with each equation estimated identical to (3.9.k.1) in theory.

Industry three (textile mill products and other fabricated textile mill products) and industry four (food and kindred products) were the two individual nondurable manufacturing industries included. In addition, data from the chemicals and allied products industry were included in the calculation of variables used for the nondurable industry (ND). This equation represents the total effect of each exogenous shifter on nondurable manufacturing employment from these industries. Tables 8, 9, and 10 give the nondurable manufacturing equations and parameter estimates. All equations were estimated with ordinary least squares.

Exogenous variables explained as much as 83 percent of the total variation in the urban counties in the textiles equation. Explanatory power for all counties was 72 percent with 32 percent of the variation explained for the nonurban counties. Explanatory power fell substantially in the food and kindred products equation where only 40 percent of the variation was explained in the urban group. Explanatory power was quite low for all counties and in the nonurban group at 28 percent and 10 percent, respectively. Explanatory power for the total nondurable equation was between that of the individual industry equations. Corrected coefficients of determination were not substantially different.

Dependent Variables

Average employment change patterns between industries varied quite substantially. Average employment change for the textiles and other fabricated textile products was quite consistent in all three

Table 8. Regression equations for textile mill products and other fabricated textile products employment change (E_3) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	238.30	446.10	241.70
Education (X_1)	-.4799* (.2610)	-1.2722 (.7672)	-.2270 (.2323)
CE (X_2)	.0051 (.0037)	.0024 (.0125)	.0044 (.0030)
PL-566 (X_3)	.0343 (.0907)	.0065 (.2329)	.0792 (.0821)
ACP (X_4)	.0686 (.0613)	.1953 (.1896)	.0112 (.0529)
FHA (X_5)	.0020 (.0248)	.0190 (.0600)	-.0143 (.0232)
Product price (PP_3)	-.4700 (2.7620)	-16.6440 (14.3500)	-.1181 (2.1130)
Wages (FP_3)	-.0266 (.0227)	-.0323 (.0541)	-.0138 (.0209)
Technology (Z_3)	-.8103 (1.0750)	-4.5918 (4.7150)	-.0269 (.8504)
Wage opportunity (WWM)	-3.1554 (6.4600)	34.3810 (25.4300)	-11.9390** (5.1000)
Employment opportunity (WE_3)	.1472 (.0965)	.2603 (.1811)	-.0575 (.1346)
Number of firms (N_3)	97.2050*** (3.4410)	105.5400*** (6.4310)	62.8000*** (6.5150)
Dummy (GRP)	-108.3600** (54.3600)	--	--
R^2	.72	.83	.32
$\bar{R}^2$	.71	.80	.29
Number of observations ^c	367	90	277

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 9. Regression equations for food and kindred products employment change (E_4) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	269.80	277.60	82.52
Education (X_1)	-.1210 (.1447)	-.1050 (.4485)	-.0204 (.0933)
CE (X_2)	-.0067*** (.0020)	-.0173** (.0066)	-.0009 (.0012)
PL-566 (X_3)	.0568 (.0514)	.2070 (.1395)	-.0310 (.0332)
ACP (X_4)	.0232 (.0340)	.1834 (.1127)	-.0207 (.0208)
FHA (X_5)	.0007 (.0138)	-.0139 (.0360)	.0182 (.0091)
Product price (PP_4)	-13.9950*** (3.6170)	-51.1450*** (12.2100)	-.9850 (2.1560)
Wages (FP_4)	.0081 (.0119)	.0499 (.0353)	-.0050 (.0074)
Technology (Z_4)	1.9102 (1.8900)	17.0690* (9.2860)	-.6951 (1.0430)
Wage opportunity (WWM)	2.9056 (2.7000)	17.0650 (15.9300)	.6182 (1.4890)
Employment opportunity (WE_4)	.1329 (.2336)	.9148 (1.2560)	.0603 (.1253)
Number of firms (N_4)	11.2850*** (1.6330)	10.3570*** (2.9550)	15.6860*** (3.7200)
Dummy (GRP)	-133.5000*** (30.0400)	--	--
R^2	.28	.40	.10
$\bar{R}^2$	.25	.31	.06
Number of observations ^c	363	89	274

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 10. Regression equations for nondurable manufacturing employment change (E_{ND}) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables	All counties	Urban counties	Nonurban counties
Constant	443.70	931.60	289.50
Education (X_1)	-.6131* (.3538)	-1.4924 (1.3130)	-.2492 (.2540)
CE (X_2)	.0101** (.0050)	.0333* (.0190)	.0049 (.0034)
PL-566 (X_3)	.0474 (.1258)	.0270 (.3899)	.0768 (.0919)
ACP (X_4)	.0357 (.0831)	-.1022 (.3067)	.0141 (.0583)
FHA (X_5)	.0113 (.0339)	.0077 (.0976)	.0077 (.0256)
Product price (PP_{ND})	-3.0465 (3.7360)	-5.0645 (18.5200)	-2.2268 (2.4080)
Wages (FP_{ND})	-.0382 (.0310)	-.0814 (.0969)	-.0122 (.0231)
Technology (Z_{ND})	.2835 (1.4860)	-2.4102 (8.4102)	.1593 (.9262)
Wage opportunity (WWM)	-4.1241 (6.4600)	7.6992 (43.7800)	-6.8404 (4.1580)
Employment opportunity (WE_{ND})	-.8445 (1.5430)	-2.5378 (6.4100)	.2514 (1.0630)
Number of firms (N_{ND})	39.7860*** (2.5880)	36.7430*** (5.3150)	51.6110*** (5.6530)
Dummy (GRP)	-64.5420 (73.8100)	--	--
R^2	.44	.50	.29
$\bar{R}^2$	.42	.42	.26
Number of observations ^c	372	90	282

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

groups (Appendix B, Table 18). However, standard deviations were quite large which indicates isolated county employment patterns for textiles and fabricated textile products.

Average employment change for food and kindred products was negative for all county groups except the nonurban counties. The urban counties showed a decline of substantial magnitude when compared to the other areas (Appendix B, Table 18). Comparison of the standard deviations also indicated some variation among counties.

Total employment change for the nondurable industries group also varied among the delineated groups. The nonurban group of counties demonstrated the largest average increase while the urban group experienced the smallest increase of slightly more than one-third of the nonurban increase (Appendix B, Table 18). Large variations between counties were indicated for the urban counties.

Exogenous Shifters

Sufficient data were available on all the nondurable industries to include all independent variables. Each equation discussed is identical in theoretical construction and variables included.

Education investments.--Changes in per pupil education expenditures demonstrated a negative effect in the three nondurable equations for all groups. A low level of association was noted for the group of all counties in both the textiles and nondurable equations. Nondurable manufacturing industries employ a high proportion of nonskilled laborers since many of the jobs are in processing plants and mill type work. Traditionally, the types of firms in these industries, particularly in the textile industry, have attempted to locate and relocate in areas

where a large quantity of low-cost labor was available. This observation might explain two apparent trends indicated in nondurable employment patterns. First, increases in education expenditures have in general contributed negatively to employment changes in nondurables which might indicate the migration of a more highly educated work force out of these particular industries and the areas in which the industries are located. Second, the average increase in nondurable employment for nonurban counties was larger than the other two areas indicating a possible movement toward a lower cost work force. These should be offsetting movements depending on the rate of education expenditures and the number of nondurable firms in nonurban areas.

Corps of Engineers' investments.--The effects of Corps of Engineers' investments were consistent along industry lines rather than county groups. Investments by the Corps indicated a negative effect in all three groups for food and kindred products with high significant relationships demonstrated in the group of all counties and the urban county group. Positive effects were indicated for textiles and the total nondurable equation in all groups. A significant effect was demonstrated for all counties and the urban counties for the nondurable equation. The two groups demonstrating significant relationships received the largest average investments.

Consistency of coefficient signs for these equations seems to indicate consistent differences in employment patterns for the various industries. A negative effect on agricultural employment and farm numbers by Corps of Engineers' investments was demonstrated in an earlier section. It is of interest that the same negative effect is indicated for food and kindred products manufacturing since this industry is highly

dependent on agriculture. It appears that firm consolidation may also be occurring in food and kindred products with resultant decreases in employment. Nondurable manufacturing in general apparently increased as the result of Corps of Engineers' investments. Nondurable industries use large amounts of water and should benefit as indicated from increased supplies of raw products made available from flood protection.

Small Watershed Program investments.--Investments in the Small Watershed Program indicated a consistent positive effect for all three groups in the three nondurable equations. The only negative coefficient appeared in the food and kindred products equation for the nonurban counties. None of the coefficients showed a significant level of association. Investments in this program would be expected to influence nondurable manufacturing employment through secondary and tertiary effects. That is, enough time must elapse for a program investment to increase the output of fiber and raw food products in an area so that the processing of these additional products will increase employment. It is apparent that either this effect did not occur or that inadequate time passed to measure the full effect. It also remains possible that processing occurred outside the investment county and the total effect was not measured.

Agricultural Conservation Program investments.--Conservation measures available through this program would be expected to have similar effects on manufacturing employment as the Small Watershed Program. Some time delay would be involved before conservation measures could influence food and fiber output of sufficient degree to appreciably affect nondurable manufacturing employment. In consideration of these

factors, coefficient signs and association levels were consistent with those experienced with the Small Watershed Program. All effects were positive with the exception of the urban counties for the total non-durable equation and for the nonurban counties in the food and kindred products equation. The only sign difference between this investment category and the Small Watershed Program was the negative sign found in the urban group. No significant levels of association were determined.

Farmers Home Administration investments.--Community water and sewer system investments could conceivably influence manufacturing firms to locate in a particular community because of the advantages these systems might afford both the firm and its employees. Time delay problems in measuring these responses to an initial investment also exist with this factor supply category. Response to water and sewer system loans and grants was generally positive with several exceptions. Negative effects were noticed for food and kindred products in the urban counties and for textiles in the nonurban counties. The pattern of no significant coefficients evident in the last two investment categories also occurred with water and sewer system grants.

Manufacturing product price.--Increases in product price¹ would normally be expected to increase employment. Existing firms would be expected to increase output and new firms would be encouraged to enter the industry in an attempt to benefit from higher residual returns to firms. Too many new firms could cause residual returns to decrease with an offsetting reduction in firm numbers and employment. This offsetting decline could be more substantial than the initial increase.

¹All product price indexes used 1958 = 100 as the base.

It appears likely that the indirect effect on new firms, i.e., a reduction in firm numbers and employment due to reduced returns as the result of expanded output, was large enough to offset the initial positive effect. All product price increases in the nondurable equations resulted in negative employment effects in all three groups. High levels of association were indicated for food and kindred products for the group of all counties and the urban county group. A correlation coefficient of .5 was noted between manufacturing product price and manufacturing technology in the urban group.

Average product price increases were fairly consistent in all three groups for both textiles and food and kindred products. There was slightly more variation in the urban group. Intracounty variation within each group was fairly small. Product price changes in the textile and fabricated textile products industries ranged from fairly substantial increases to some minor decreases. Textile mill product prices rose 8.9 points while fabricated textile product prices increased by 14.4. The largest increase in textiles of 78.3 occurred in narrow fabric mills products while decreases of 7.5 occurred in both knitting mills products and floor coverings. Fairly uniform increases of 14.4 occurred in the fabricated textile industry with only a few products showing a decrease of 11.0.

Food and kindred product prices showed a larger increase in the price index changing by 24.2 points. Within the industry, dairy products experienced the largest increase of 31.5 while miscellaneous food products increased the least by 17.3 index points. Average price change for all nondurables was 21.9 index points. Chemical product prices which

were included in the total nondurable computation experienced both increases and decreases among its products.

Manufacturing wage rate.--Wage increases would affect employment in either of two ways. For industries where other factors could not be substituted for labor in the production process, wage increases would be associated with increases in labor employment. Conversely, in industries where labor was replaceable by other factors, wage increases would cause a decline in employment. Wage increases could reduce firm residual returns to such degree that the firm would relocate or exit from the industry. The effect of wage increases was negative in all three groups for both textiles and the total nondurable equation. Negative effects for food and kindred products were experienced in the nonurban group. None of the wage effects exhibited significant levels of association.

Average wage changes did vary somewhat among the three groups. The urban counties demonstrated the largest wage increases for all three nondurable categories. Wage increases for the three industries were consistent and county variation within groups minimal (Appendix B, Table 22).

Manufacturing technology.--Technology increases would generally be expected to reduce employment in a given area. The expected effect of increases in output per man-hour through the use of new equipment and/or different production techniques would be a decrease in the demand for labor and consequently a negative effect on employment. Negative effects did occur for textiles in all three groups although none of the coefficients were significant. A somewhat different pattern emerged for food and kindred products and all nondurable products. Positive

employment effects were demonstrated for food and kindred products in the group of all counties and the urban group. The urban group coefficient indicated a low level of significance. Positive coefficients were indicated for all nondurables in the group consisting of all counties and the nonurban group. It seems apparent that in food and kindred products and in all nondurable products that technology increases may have been labor increasing. Output expansions were sufficient to overcome any labor decreasing effects of the technology.

Technology or output per man-hour index average increases² were fairly uniform among groups for both textiles and food and kindred products. However, the increase was about three times larger for food and kindred products than for textiles (Appendix B, Table 23). For all nondurables, the urban group of counties showed a larger increase than either textiles or food and kindred products. More county variation was indicated for textiles and all nondurables than for food products where intracounty variation was quite small.

Changes in the output per man-hour indexes for three-digit manufacturing industries which were used to compute county indexes did vary substantially in some cases. Changes in textile mill products indicated a decrease in the wool weaving and finishing mill products index of 36 points while all other industries exhibited increases with the maximum increase of 55 in floor covering mills products. An interesting observation here is that this particular industry suffered price decreases during the same period. Apparel and fabricated textiles had three decreases with the maximum decrease of 41.5 points occurring in women's

² Indexes developed used 1958 = 100 as base.

and misses' outerwear. A maximum increase of almost 76 points occurred in hats, caps, and millinery products. Food and kindred products experienced increases in all industries with the maximum of 53.5 occurring in beverages. Chemicals which were included with other nondurables for the total nondurable equation exhibited substantial increases in all industries with the maximum of 104.7 occurring in gum and wood chemicals.

Manufacturing wage opportunity.--Changes in wage opportunities demonstrated a varying pattern of effects both among groups and non-durable industries. A negative effect on employment was indicated for all counties and the nonurban group for textiles with the latter group demonstrating a significant level of association. Since average wage changes in this industry were relatively lower than in other industries, it seems apparent that the opportunity cost of remaining in textile employment was large enough to induce employees to take advantage of alternative wage opportunities.

A positive effect was demonstrated in all groups for food and kindred products although no significant levels of association were apparent. Alternative wages may not have been high enough to entice labor employment to leave the industry. Since this is a low-skilled industry, it is more likely that employment skills were not sufficient for employees to leave this industry and transfer their skills to another industry.

The pattern emerging for all nondurables was negative with the exception of the urban group. It appears that for nondurable employment in general the opportunity cost of remaining employed was large enough to influence some degree of movement to other job alternatives.

Manufacturing employment opportunity.--The effect of increases in employment opportunities was mixed with no significant levels of association noted. Negative effects were indicated for textile products employment in the nonurban group and for all nondurables in the all county group and urban group.

Food and kindred products had positive effects in all groups. This same relationship was indicated for the wage opportunity variable giving further support to the hypothesis that skills in this industry are prohibitive in the movement of labor employment from this industry. The negative coefficients mentioned did indicate that some movement in labor employment was occurring.

Average employment opportunity increases were by far the largest for textiles in the urban group with almost 190 new jobs per textile worker. Rates for the all county group and nonurban group were slightly less than one-half and one-fourth that of the urban group, respectively. Job opportunities for food products were fairly consistent among all three groups. Increases in job opportunities for all nondurables were lower than those of the individual industries as would be expected. Group averages were fairly consistent in size (Appendix B, Table 25).

Number of firms.--Increases in the number of firms would be expected to increase employment in that industry. It is possible that firm consolidation to a fewer number of larger size firms could indicate a reduction in firm numbers and yet an increase in industry employment. It was apparent for nondurables both individually and in total that firm number changes and employment changes moved in the same direction. The effect of changes in firm numbers was positive and highly associated with employment changes for each group in all three nondurable equations.

Average change in textile firm numbers ranged from slightly greater than one in the nonurban group to slightly less than two and one-half in the urban counties with the average change in employment following basically the same pattern. Average change in firm numbers for food and kindred products was negative for all groups with the urban counties demonstrating the largest decrease. These two groups experienced the largest decreases in food products employment. The smallest decrease in firm numbers occurred in the nonurban group. This group was the only one experiencing a small employment increase. This indicates a movement to larger firms in the nonurban counties. Positive coefficients for this industry indicate similar directional movements in firm numbers and employment since both have been decreasing. It appears likely that for the nonurban group firm number decreases have not been great enough to cause an average decrease in employment.

Small increases in the number of total nondurable firms were indicated for all three groups (Appendix B, Table 19). The positive effect of firm numbers on employment would be expected since total nondurable employment generally increased for all groups. There were large variations among counties in firm number changes.

Group differences.--A significant difference between the urban and nonurban groups was indicated for both textiles and food and kindred products. No significant difference was indicated for the total nondurable equation. Grouping of the two individual industries and chemicals to construct the total nondurable equation aggregated out of existence individual industry differences between the urban and nonurban groups. Average employment change for all three industries was smaller in the urban group since a negative coefficient was determined for this variable.

Durable Manufacturing

Three individual industries and the total durable manufacturing industry were included for analysis. Industry five was the transportation equipment industry. Lumber and wood products and furniture and fixtures comprised industry six while electrical equipment and supplies comprised industry seven. Four additional industries were combined with these to constitute the total durable manufacturing equation. These four industries were paper and allied products, stone, clay, and glass products, primary metal products, and fabricated metal products. Each equation was identical to equation (3.9.k.1) in theoretical construction with a slight exception in industries five and seven. Product price data for transportation and electrical equipment were inadequate for the inclusion of this variable in the equations. This differentiation should be noted as general comparisons of these equations are made with the other two equations. Estimated coefficients for the four durable equations are given in Tables 11, 12, 13, and 14 with all equations estimated by ordinary least squares.

The exogenous variables explained as high as 24 percent of the total variation in employment change for the transportation equipment equation for all counties. Explanatory power fell in the other two groups with 22 percent explained for the urban counties and 17 percent for the nonurban group. Explanatory power was even less for industry six where maximum percentage explained of 22 percent occurred for the urban group. Explanatory power was relatively higher for the remaining two groups. Fifty-five percent was explained in the all county group for transportation equipment. The urban county group experienced explanatory power of 54 percent with the nonurban group at 30 percent. The urban

Table 11. Regression equations for transportation equipment products employment change (E_F) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	281.30	134.80	234.10
Education (X_1)	.9488 (.4274)	1.7013 (1.4710)	-.1461 (.1408)
CE (X_2)	.0004 (.0065)	.0013 (.0254)	-.0013 (.0020)
PL-566 (X_3)	-.1178 (.1470)	-.1240 (.5270)	.0101 (.0472)
ACP (X_4)	-.0504 (.0993)	-.0055 (.3950)	-.0129 (.0312)
FHA (X_5)	-.0567 (.0398)	-.0791 (.1268)	-.0261* (.0135)
Wages (FP_5)	.1153*** (.0373)	.2625** (.1276)	.0269** (.0122)
Technology (Z_5)	-18.7450* (10.1300)	-24.8780 (28.8300)	-5.6737 (3.8760)
Wage opportunity (WWM)	-44.8530*** (14.3500)	-127.0800** (63.6500)	-15.1340*** (4.2770)
Employment opportunity (WE_5)	-.2348* (.1330)	-.7591 (.5372)	.0045 (.0406)
Number of firms (N_5)	39.2250*** (7.8710)	30.5550 (19.0700)	46.3260*** (10.9400)
Dummy (GRP)	268.0900*** (87.9100)	--	--
R^2	.24	.22	.17
$\bar{R}^2$	.22	.12	.14
Number of observations ^c	344	86	258

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 12. Regression equations for furniture and lumber and wood products employment change (E_6) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	214.00	478.40	45.06
Education (X_1)	.2002* (.1091)	.2705 (.3285)	.1550 (.1043)
CE (X_2)	.0010 (.0016)	.0028 (.0049)	.0002 (.0015)
PL-566 (X_3)	-.0232 (.0403)	.0027 (.1008)	-.0275 (.0398)
ACP (X_4)	-.0223 (.0269)	-.0362 (.0836)	-.0083 (.0258)
FHA (X_5)	.0473*** (.0109)	.0591** (.0260)	.0419*** (.0112)
Product price (PP_6)	-7.0494*** (2.3940)	-19.6250*** (7.2510)	-.4624 (2.2320)
Wages (FP_6)	-.0114 (.0087)	.0057 (.0217)	-.0171* (.0091)
Technology (Z_6)	-3.5861*** (.9503)	-6.8045** (2.7710)	-2.0076** (.8818)
Wage opportunity (WWM)	.2808 (1.9110)	5.5614 (11.3600)	.1800 (1.7170)
Employment opportunity (WE_6)	.2484*** (.1243)	.0502 (.2065)	.9489** (.3697)
Number of firms (N_6)	-1.2626 (.8443)	-1.6980 (1.9960)	-.7391 (.8872)
Dummy (GRP)	-72.1580*** (25.0000)	--	--
R^2	.13	.22	.11
$\bar{R}^2$	.09	.11	.08
Number of observations ^c	373	90	283

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 13. Regression equations for electrical equipment products employment change (E_7) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	-63.66	-287.90	32.42
Education (X_1)	.3669 (.2594)	1.3037 (.8308)	.0146 (.1118)
CE (X_2)	-.0003 (.0035)	-.0048 (.0130)	.0005 (.0014)
PL-566 (X_3)	-.0488 (.0843)	-.1476 (.2569)	.0230 (.0355)
ACP (X_4)	.0580 (.0590)	.2375 (.2016)	-.0082 (.0248)
FHA (X_5)	.0061 (.0227)	-.0220 (.0651)	.0307*** (.0101)
Wages (FP_7)	.0056* (.0033)	.0088 (.0107)	.0013 (.0100)
Technology (Z_7)	-1.2353 (3.3920)	-2.1746 (9.1240)	-1.8103 (1.6340)
Wage opportunity (WWM)	-14.3330 (8.9540)	-27.4060 (28.7400)	-4.8866 (3.7650)
Employment opportunity (WE_7)	-.0654 (.0655)	-.1918 (.2135)	.0051 (.0281)
Number of firms (N_7)	109.4300*** (7.1580)	106.0400*** (15.7700)	99.9960*** (14.0100)
Dummy (GRP)	79.0500 (51.0300)	--	--
R^2	.55	.54	.30
$\bar{R}^2$	.53	.48	.26
Number of observations ^c	302	86	216

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 14. Regression equations for durable manufacturing employment change (E_D) for all counties, urban counties, and nonurban counties, 1960 to 1970^a

Independent variables ^b	All counties	Urban counties	Nonurban counties
Constant	569.30	493.50	428.90
Education (X_1)	.3676 (.6816)	2.2035 (2.3800)	-.2572 (.2454)
CE (X_2)	.0187** (.0095)	.0662* (.0363)	-.0027 (.0033)
PL-566 (X_3)	-.0299 (.2413)	-.8338 (.7400)	.1726* (.0899)
ACP (X_4)	-.1187 (.1597)	-.2129 (.5997)	.0739 (.0568)
FHA (X_5)	-.0361 (.0657)	-.1895 (.1920)	.0635** (.0251)
Product price (PP_D)	-25.4810*** (8.4980)	-50.8180 (32.7400)	-10.8510*** (2.9720)
Wages (FP_D)	.1803*** (.0588)	.4848*** (.1796)	.0109 (.0224)
Technology (Z_D)	-8.7125 (5.2910)	-20.3460 (18.1200)	-.8472 (1.8770)
Wage opportunity (WWM)	-40.3770*** (11.7600)	-226.9500*** (84.1400)	-3.0174 (3.8310)
Employment opportunity (WE_D)	16.2310*** (4.4320)	17.7150* (9.9810)	-1.2446 (2.4640)
Number of firms (N_D)	12.1020*** (2.8500)	6.8617 (6.1950)	-2.0249 (1.9380)
Dummy (GRP)	193.2700 (160.2000)	--	--
R^2	.28	.39	.16
$\bar{R}^2$	.26	.30	.13
Number of observations ^c	370	90	280

^aStandard errors in parentheses. ^bComplete variable definition in Chapter III. ^cCounties excluded if no employment reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

county group had the largest amount of variation explained for all durables at 39 percent. The all county group was next at 28 percent while the nonurban group was 16 percent.

Dependent Variables

Substantial variation was indicated among groups in average employment change for the various durable industries. Transportation equipment average employment change was the largest in the urban counties with a change of over 600 employees. Average change for all counties was slightly over 200 employees while the nonurban groups change was one-sixth that of the urban group.

Average employment change for lumber and wood products and furniture and fixtures was negative for all three groups with very little variation among groups in magnitude of change (Appendix B, Table 18). Electrical equipment average employment change also varied substantially with the urban counties showing the largest increase of 370 employees. The smallest increase of 50 employees occurred in the nonurban counties. Total durable manufacturing average employment change was the largest in the urban group with a change of 1,059 employees.

Exogenous Shifters

Exogenous shifters included in the durable equations were identical in method of derivation to those used in the nondurable equations. Product price was not included in transportation equipment and electrical machinery equations because of inadequate data.

Education investments.--Increases in per pupil education expenditures demonstrated a consistently positive effect on employment with only two exceptions. These occurred in the nonurban groups for both trans-

portation equipment and all durable manufacturing. The only significant level of association occurred in lumber products employment for the group containing all counties.

The effect demonstrated for durables was generally opposite that experienced for nondurables. It appears evident that durable manufacturing industries benefit directly from a more educated and higher skilled work force as opposed to nondurables. Even though employment decreased in lumber and furniture the education effect was positive.

Corps of Engineers investments.--Investments by the Corps of Engineers produced a more varied response for durable manufacturing than was noticed for nondurable. Positive and significant effects were indicated for durable manufacturing in both the all county group and urban counties. No other significant levels of association were obtained. Negative coefficients were indicated for electrical equipment manufacturing employment for both the all county group and the urban group. Increases in water supplies, protection from flooding, and improved transportation are all products of Corps of Engineers investments. These improvements should increase manufacturing activity in a given area. The mixed response for durable manufacturing employment indicates that the effect is highly dependent on the industry considered and area in which the industry is located.

Small Watershed Program investments.--Investments in the Small Watershed Program also gave a somewhat contrasting effect in durables as opposed to nondurables. Most groups demonstrated a generally negative effect as compared to the positive effect demonstrated in nondurables. The only group showing a significant level of association was the non-urban group for durable manufacturing. This occurred despite relatively

small employment changes for durable manufacturing in the nonurban group. The negative coefficients indicate that possible improvements in factors of production in an area lead to intensification of agricultural activity rather than manufacturing activity. Investments of these types would also be expected to influence nondurable manufacturing employment to a larger extent than durable manufacturing employment. The large numbers of positive employment effects for nondurable manufacturing as compared to durable manufacturing employment support this hypothesis.

Agricultural Conservation Program investments.--The same general pattern emerged with investments in this program for durables as with the Small Watershed Program. The majority of coefficient signs indicated a negative effect on employment in contrast to the generally positive effect indicated for nondurable manufacturing. No significant levels of association were noted. Agricultural Conservation Program investments would also be expected to influence both agricultural activity and nondurable manufacturing activity in a given area at the expense of durable manufacturing activity.

A negative effect was indicated for transportation equipment employment for all groups. Lumber and wood products also exhibited a negative effect for all three groups. The nonurban group demonstrated negative effects for electrical equipment. Total durable employment was affected negatively for all groups except the nonurban group.

Farmers Home Administration investments.--Loans and grants made by the Farmers Home Administration seemed to be more important in durable manufacturing than in nondurable manufacturing employment. The effect on transportation equipment employment was negative for all groups with a low level of significance determined for the nonurban group. High

levels of association were indicated in all groups for the lumber and furniture products industry with all employment effects positive. Lumber and wood products and furniture manufacturing are usually located in rural areas near the raw product source. Investments in community water and sewer systems which are often made in rural areas seemed to have been important in influencing employment in this industry. Although this was a generally declining industry in terms of people employed, loans and grants for water and sewer systems may have been important in increasing local area employment.

Positive effects were demonstrated for electrical equipment employment for all groups except the urban group with a high level of association noted for the nonurban group. Total durables demonstrated a pattern somewhat similar to transportation in that all effects were negative except for a significant positive effect in the nonurban group.

The importance of this program for the nonurban counties seemed to be consistent for all durable industries, although the nonurban counties as a group did not receive average loans and grants as large as some of the other groups. Only one industry indicated a negative effect. All four industries examined did exhibit some level of significance in the nonurban group of counties. Since individual counties in this group received substantial investments it seems likely that they influenced the entire group. This program was insignificant for the nonurban group in the nondurable employment equation. This program has been in effect longer in many of the counties which constitute the nonurban group than for the urban counties.

Manufacturing product price.--Product price increases seemed to influence employment in durable manufacturing similarly to the effect in

nondurables. The transportation and electrical equipment equations did not have the product price variable included. Price increases in the lumber and wood products industry demonstrated a highly significant negative effect for both the all county group and urban county group. The nonurban group also showed a negative effect. Average product price increases were fairly consistent among groups. Total durables also demonstrated negative effects in all groups with very high levels of association indicated for all counties and the nonurban group.

There were some differences in average product price increases for all durables with the nonurban counties showing the largest change of 25.3 points and the urban counties a change of 16.5 points.³ The other three groups varied between changes of approximately 20 to 23 index points (Appendix B, Table 21). Intracounty variation was quite low. Changes in the product price index for lumber and furniture products were fairly consistent with the group averages varying from 26.4 to 29.2. Price changes in the lumber and wood products industry did vary somewhat within the industry. Plywood, millwork, and wooden containers experienced the smallest change of 16.5 while the raw products of logging contractors experienced the largest change of 37.9 index points.

Price changes in furniture and fixtures were fairly consistent with an increase of slightly greater than 24 in all three-digit level industries except for miscellaneous furniture and fixtures which increased 37.4 index points. Price changes for the remaining four industries used in determining price changes for all durables were fairly consistent except for paper and allied products. This industry showed a price

³All product price indexes used 1958=100 as the base.

decrease for building paper and paper board and fairly small increases in several other industries. Only papermill products, excluding building paper, demonstrated an increase on the same magnitude as the other three two-digit level industries. Stone, clay, and glass, and both fabricated and primary metals showed price increases generally around 20 index points.

Product price increases were correlated with technology changes in the all county group. The level of correlation was $-.53$.

Manufacturing wage rate.--The effect of wage changes on employment was consistent along industry lines for durables as it was for nondurables. Wage increases seemed very important in influencing employment changes for transportation equipment manufacturing. All three groups demonstrated significant positive effects. Even though wages did increase substantially in transportation when compared to other industries, particularly nondurables, it is apparent that labor could not be replaced by other production factors. The effect on lumber and furniture products employment was negative for all groups except the urban group. Average wage increases in this industry were consistent with those in the other durable industries. This indicates that labor employment has been replaced by other resources as the result of the higher wages.

Positive employment effects were demonstrated for both electrical equipment and all durables for all three groups. Levels of significance were indicated in the group containing all counties for electrical equipment and in the all county group and urban group for all durables. It seems evident that wage increases were not sufficient to cause labor replacement or that labor could not be replaced in the physical production process for these two industries.

Average wage increases for durables were generally larger than those in nondurables. Electrical equipment wages changed the greatest amount. Average annual wage change for electrical equipment in the urban group was approximately \$4,270. This was much higher than any other group. Changes in nondurables normally ranged from approximately \$2,100 to \$2,800 with the larger changes usually occurring in the urban group of counties. Intracounty variation was normally small.

Manufacturing technology.--Changes in technology gave the expected effect in each durable equation. Increases in technology contributed to decreases in employment for all three groups in the transportation equation with a low level of association noted for the group consisting of all counties. A more definite effect was demonstrated for lumber and furniture products where all groups demonstrated highly significant negative effects. This industry suffered a decline in average employment for each group in the decade under study with the apparent addition of either output increasing and/or labor input decreasing capabilities to their production processes. This consistent negative effect also substantiates earlier observations about the apparent effect of wages and prices on employment in this industry. The remaining two industries were consistent in sign with a priori expectations but did not demonstrate significant levels of association.

Average changes in output per man-hour indexes were fairly consistent within each industry.⁴ Average technology changes in the

⁴Indexes developed used 1958=100 as base.

transportation equipment industry were extremely consistent among groups with a change of about 13 index points. Substantial index variation was seen within the industry. Changes in the index varied from slightly less than six index points in railroad equipment to 36 points in motorcycles and bicycles. Average technology changes for lumber and furniture manufacturing were approximately 25 index points for most of the groups. Intraindustry variation was substantial as lumber and wood products had three-digit industries experiencing changes as low as six points (miscellaneous wood products) and as high as 67.6 points (wooden containers). Furniture and fixtures had one industry that declined slightly over three points (office furniture) while increases in the remaining industries were rather low with miscellaneous furniture showing the largest increase of slightly less than 16 points.

Electrical equipment output per man-hour changes also were erratic with changes ranging from a decline of almost 24 points in radio and television receiving equipment to an increase of almost 37 in household appliances. The remaining industries which were used for total durables also exhibited substantial variation. Paper and allied products had one major increase of slightly over 100 points in building paper and paperboard with the remaining industries increasing approximately one-third this much. Stone, clay, and glass exhibited increases ranging from less than one in products of purchased glass to over 55 in hydraulic cement. Primary metals had two industries that experienced decreases in the technology index with the largest decrease occurring in nonferrous foundries products. The largest increase of over 43 points occurred in primary nonferrous metal products. Fabricated metals had the largest of three decreases to occur in metal stampings where 16.4 points were

lost. The largest increase of 56.2 points occurred in nonelectrical plumbing and heating equipment. This increase was approximately double that of any other industry within fabricated metals. Much of this variation was removed when county changes were computed according to their value of output with intracounty variation within each of the three groups not excessively larger.

Manufacturing wage opportunity.--Effects on employment of increasing wage opportunities were very consistent along industry lines for durable industries. The effect on the transportation industry of changes in wages in other industries was negative for all groups with high levels of significance noted for each group. This consistently negative effect makes it apparent that the opportunity cost of staying in textiles was large enough to encourage employees to take advantage of higher wage alternatives. The effect in lumber and furniture was positive for all groups. No significant coefficients were observed. Low-skilled labor employment in this industry may not have been able to take advantage of alternative employment opportunities.

Wage opportunity effects for electrical equipment were consistently negative for all groups but did not seem to be significantly important in explaining employment changes for that industry. Electrical equipment is a relatively high wage paying industry. This reduces the number of opportunities to leave the industry to obtain higher wages. Average wage opportunities for the industry were lower than for any other industry with only one minor exception in the urban group for transportation equipment. This indicates why the effect was in the expected direction but at nonsignificant levels. Wage opportunity effects for all durables were also negative for all groups with only

the nonurban group not highly significant. This consistent effect seems to indicate that employees in durable manufacturing are influenced by alternative wage opportunities and that the opportunity cost of remaining in durable manufacturing employment is sufficiently large to influence employment changes. Average increases in wage opportunities were consistent in magnitude among groups for all four durable industries used. The nonurban group demonstrated the largest increase (Appendix B, Table 24).

Manufacturing employment opportunity.--The effects of increases in employment opportunity were more mixed than wage opportunity but were generally consistent in sign with wage opportunity effects. Negative effects were demonstrated for transportation equipment manufacturing for all groups except the nonurban group with some significant association noted for the group containing all counties. These effects complement the observations made in opportunity wages that activities in other industries affect employment in transportation equipment manufacturing. Electrical equipment manufacturing demonstrated a similar effect to transportation in that all groups except the nonurban group exhibited a negative effect. No significant levels of association were noted.

Positive effects were prevalent in both lumber and furniture and total durables. Highly significant positive effects occurred in both the all county group and the nonurban group for lumber and furniture products employment. Positive effects were also demonstrated for durables in all groups except the nonurban group with significant effects noted in the urban group and the all county group. Average employment opportunities were also smaller for these groups with the exception of

the urban group. It appears that for these two industries employment increases were complementary to employment increases in other industries.

Electrical equipment experienced the largest average employment opportunity with the urban group demonstrating the largest increase of 256 employees for each electrical employee. The other groups averaged about two-thirds' this rate of increase. The next largest average employment opportunity occurred in transportation with a maximum increase of 178 employees per transportation employee occurring in the urban group. Furniture and lumber average employment opportunity was lower with the urban counties demonstrating an average of approximately 64 employees.

Number of firms.--Changes in the number of firms were also important in explaining employment changes in durable manufacturing. Increases in the number of transportation equipment manufacturing firms contributed positively to employment with highly significant effects noted for both the nonurban group and the group consisting of all counties.

A contrasting situation was determined for lumber and furniture products manufacturing where all effects were negative. Average firm number changes were fairly consistent for all groups. Movement to a larger number of firms in this industry seemed to decrease employment. It becomes apparent that technology increases have demonstrated major influence in this industry and that the larger number of firms actually need fewer employees.

Positive and highly significant effects were demonstrated for all three groups in electrical equipment manufacturing although average firm number increases were fairly small. Coefficient size for increases in firm numbers indicates that new firms in this industry may be quite

large in terms of the number of employees and that the addition of one new firm occupies an important position in determining employment patterns in the area of its location. Positive effects were also demonstrated for all durables in each group except the nonurban group. The all county group was the only group demonstrating any significance with a high level of association indicated.

Group differences.--Significant differences between the urban and nonurban counties were noted for two of the industries included in the durable manufacturing analysis. Highly significant differences were indicated for both the transportation and lumber and furniture industries. No significant differences were noted for electrical equipment and all durables. Inclusion of the urban counties would generally cause a lower intercept for lumber and furniture and a larger intercept for the other three durable equations. This demonstrates the importance of these individual industries in the two diverse groups of counties.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The general objective of this study was to examine the importance of investments in human and natural resources along with several other variables in explaining employment changes within county groups for the four-state region of Mississippi, Alabama, Georgia, and Florida during the time period 1960 to 1970. A theoretical economic model was developed and used in an attempt to explain changes in employment and firm numbers brought about by exogenous shifts in the supplies of resources, demand for products, supplies of other factors, firm production possibilities, and shifters of the number of firms in an industry. Empirical analysis attempted to determine the importance of each exogenous shifter on employment in agriculture, construction, durable and nondurable manufacturing industries.

Comprehensive examination of previous analyses indicated that either water resource investments are poor tools for stimulating economic growth or inadequate methodologies have thus far been used in attempts to measure investment effects. This work represents an attempt to both improve existing methodology considering the importance of interdependencies among other important factors in a region receiving resource investments and to use the model to empirically demonstrate its applicability and determine the effect of actual resource investments.

The theoretical model developed was designed to explain absolute changes in employment as a function of exogenous changes in the prices of products, prices of factors having perfectly elastic supplies, shifters of the supply of factors assumed to have other than perfectly elastic supply functions for a region, and shifters of firm production possibilities. Changes in the number of firms were explained as a result of the same exogenous variables and exogenous shifters of firm supply functions for agriculture. Complete mathematical derivation of the theoretical model was presented. The model consisted of three basic types of components with two equations representing each component. These components were (1) product supplies and factor demands for all firms in individual types of industries, (2) aggregate product demand and factor supply functions, and (3) the number of firms in each industry.

Economic interpretation of both employment effects and firm number effects was presented. Each term and combination of terms in each of the coefficients were defined. The effect on changes in employment and changes in firm numbers as the result of changes in each of the exogenous factors was examined in detail. Graphical illustration of the equilibration process resulting from a change in supply of the n^{th} factor was given along with a mathematical discussion of the same process. Effects of changes in the number of firm entrepreneurs, product price, factor price, and firm production possibilities also received detailed mathematical discussion.

The area chosen for this study included the four states of Mississippi, Alabama, Georgia and Florida. Counties within these states were delineated into urban and nonurban counties using ten variables

designed to classify the counties according to their human and natural resource endowments, and their urban, industrial and agricultural orientations. Three groups of counties were selected for empirical analysis. One group consisted of 91 urban-oriented counties. A second group consisted of 284 nonurban-oriented counties. The third group contained all 375 counties.

Industry classifications were also determined for analysis. Nine industry classifications were specified for analysis primarily on the basis of total employment in the study area. Some consideration was given to water use criteria. These industries were agriculture, construction, textile mill products and other fabricated textile products, food and kindred products, transportation, the combination of furniture and fixtures and lumber and wood products, electrical equipment, and industry classifications to represent both durable and nondurable manufacturing products. General equations for empirical analysis were specified for each industry. The model for agriculture was a two-equation model. Both two-stage least squares and ordinary least squares were used in estimating these equations. Some deviation from the theoretical model occurred for the remaining industries where changes in the number of firms were considered an exogenous variable. For these industries single-equation models were used to estimate the functional equations for employment changes. Counties were used as the units of observation.

Exogenous shifters used in the models to explain employment and firm number changes were of five types. Changes in factor supply included changes in state and federal per pupil education expenditures, Corps of Engineers' investments, investments by the Soil Conservation

Service in the Public Law 566 Small Watershed Program, Agricultural Stabilization and Conservation Service payments in the Agricultural Conservation Program, and loans and grants for community water and sewer systems made by the Farmers Home Administration. Reductions in crop allotments were also included for agriculture. Changes in product demand were indicated by changes in derived county product price indexes. Changes in factor prices were indicated by changes in the annual wage rate for employees in each particular industry in a county. Changes in firm production possibilities were computed using changes in derived county technology indexes for each individual industry. Shifters of entrepreneur supply were considered to be variables that indicated alternative wage and employment opportunities. Farm operator age was also included in the agricultural equations.

Conclusions

Effects on employment and firm number changes as the result of the various exogenous shifters differed quite substantially among industries and among the individual groups considered. It was concluded from these variations that the exogenous shifters do have certain effects on employment and firm number changes depending on the type of shifter, the area of employment location and the type of industry under consideration. For example, certain factor supply changes were very consistent in their effect on employment and firm number changes as well as consistently influencing employment changes in given county groups.

Changes in per pupil education expenditures demonstrated both positive and negative effects on agricultural employment and farm number changes as well as in construction employment changes. The effect on

nondurable manufacturing was consistently negative as opposed to a consistent positive effect for all durable manufacturing industries. Significant effects were isolated and demonstrated no definite pattern. Positive effects were generally expected. The negative effects apparent in nondurable manufacturing employment and agricultural employment may have been the result of higher education expenditures which allowed outmigration from these industries to take advantage of newly acquired skills. These industries typically require lower skilled employees.

Corps of Engineers' investments generally demonstrated a negative effect on agricultural employment and farm numbers. This may have been the result of larger and more efficient farms made possible by the investments. The effect on construction was positive as expected with high levels of significance noted. Variation in consistency patterns for the manufacturing industries was noted. Food and kindred products manufacturing employment demonstrated consistent negative effects. Total nondurables demonstrated positive effects. Significant coefficients were observed for food and kindred products employment, nondurable manufacturing employment and durable manufacturing employment in the urban counties and the group consisting of all counties. Negative effects for this investment category could have been the result of a time period too short to measure the employment effect.

Small Watershed Program investments also demonstrated both positive and negative effects for agricultural employment and farm number changes. Negative effects were found for construction employment changes. Positive effects were demonstrated for nondurable manufacturing employment changes while negative effects were evident in durable manufacturing. This provided some contrast to the effect of Corps of

Engineers investments on these employment categories. Few levels of significance were noted.

Investments by the Soil Conservation Service in the Agricultural Conservation Program demonstrated consistently negative effects on agricultural employment and farm number changes as well as in construction employment changes. Positive effects were noted in nondurable manufacturing and negative effects were observed for durable manufacturing employment. The negative effects on farm numbers were highly significant. This indicates that the larger farms were able to take advantage of this cost-share program and in effect consolidate the smaller farms with a resultant decline in farm numbers and agricultural employment.

Farmers Home Administration loans and grants exhibited the same pattern of behavior for agriculture and construction as did the Agricultural Conservation Program. The effect in nondurables was also similar with some difference observed in durable manufacturing. Lumber and furniture products demonstrated highly significant positive effects with positive effects also occurring in electrical equipment. The nonurban group of counties demonstrated significant effects for all four durable industries. It is also quite possible that inadequate time elapsed during the study period to allow for adequate employment response to this investment category.

Allotment decreases demonstrated the effect in both employment and farm number changes that a priori expectations would dictate. Decreases in employment and farm numbers were associated with allotment reductions. Some levels of significance were noted for farm number changes in the urban counties and the all county group. Allotment reductions were significant in the all county group.

Product demand shifts as measured through increases in product price generally increased employment in agriculture. Farm number increases were also observed with high levels of significance for all county groups. Negative effects on employment for all manufacturing industries were demonstrated for all groupings of counties. High levels of association were noted for food and kindred products, lumber and furniture products, and all durables. A reduction in firm numbers and employment due to reduced returns resulting indirectly from output increases, new firms entering the industry, and consequent reductions in residual returns was apparently large enough to offset the initial increases.

Increases in agricultural wages produced generally negative effects for agricultural employment and positive effects on farm number changes. The effect of an increase in wages on construction employment was positive and highly significant. Nondurable manufacturing generally demonstrated a negative effect while durables were normally positive with several high levels of significance. Positive employment changes resulting from increases in wages indicate a situation where labor cannot easily be replaced in the production process. Decreases in labor employment would indicate that other factors were being substituted for higher priced labor.

The effect of changes in firm production possibilities or technology on employment was generally consistent with a priori expectations. Technology increases which expand output cause more agricultural employment to be required in industries that process the output. It is apparent that this type of effect occurred. Farm numbers did decline as

the result of increases in technology. Employment decreases were also observed for both nondurables and durables with some exceptions occurring for food and kindred products employment. High levels of significance were noted for transportation and lumber and furniture products employment. This indicates the importance of labor displacing technology being introduced into these two industries.

Shifters of firm entrepreneur supply were generally very consistent with a priori expectations. Increases in wage opportunities demonstrated negative effects on agricultural employment and farm number changes with the nonurban counties providing the exception. The negative effects noticed for construction were highly significant. Positive effects were generally consistent for food and kindred products and lumber and furniture products manufacturing employment. This indicates the inability of low skilled employees in these industries to take advantage of other employment alternatives. Negative effects were indicated for all other manufacturing employment industries. High significance levels were demonstrated for transportation and durable manufacturing employment.

Employment opportunity changes were consistent in most cases with wage opportunity effects on employment changes. Effects were not as apparent for agricultural employment and firm numbers as was expected. Positive employment effects were generally indicated for food and kindred products, lumber and furniture products, and durable manufacturing products. Employment increases indicate that expansion in other industries was complemented by expansion in the industries demonstrating positive coefficients.

Farm operator age was consistent with a priori expectations for all groups. Decreases in the number of farm operators 55 years of age

or older were significantly associated with decreases in the number of farms.

Changes in the number of farms and manufacturing firms were important in explaining employment changes. Increases in the number of firms in each industry led to increases in employment with the exception of the lumber and furniture industry. Most of the coefficients were significant.

Group differences between the urban and nonurban groups of counties were important for some industries. Significant differences were noticed for the construction, textiles, food and kindred products, transportation, and lumber and furniture industries.

Limitations

Several limitations concerning this study should be discussed. The first concerns data problems. When an attempt is made to define variables as used for this study sources of adequate data are normally a major obstacle. Data were used from various sources to overcome this. Sources included both investment data provided from agency files and published data of the type found in census publications. The time period under study was 1960 to 1970. Data sometimes were reported for periods that did not coincide with this period. For example, data from some census sources were for the time period 1959 to 1969. This is a problem that is always present in a research attempt of this nature. There is also some deviation from the theoretical definitions of variables. Some effects may also go unmeasured. Private investments in the same areas were not measured. These investments also should

affect employment changes. Regardless of these shortcomings, the best possible data sources were utilized and data difficulties should not appreciably affect the results offered.

Another major limitation concerns the application of the research results. Employment or firm number effects that occur as the result of a resource investment may not always occur for each individual project. This analysis suggests that in general the results as reported will occur for the given type of area. No definite statement can be made that the same effect will absolutely occur for an individual project.

Need for Further Research

Definite suggestions can be made for future research. The model presented in this study is based on economic theory as derived from the basic economic model. It seems apparent that the equations used for the empirical analysis do an average job of explaining employment changes for some industries and an excellent job in others. One major improvement which could be made is the conversion of the model presented to a time series analysis model. Incorporation of the county data into a time series analysis should provide a model that would do an even better job in explaining employment and firm number changes. Use of this type model would allow the computation of multipliers which would be quite useful in any economic analysis. The major problem that would be encountered is the availability of adequate time series data. Indexes of county product price, technology, and several other variables would have to be derived on an annual basis. Sufficient data at this time are not available to allow these calculations.

A second suggestion centers around the use of a multi-industry simultaneous equation model. This model would be better suited to time

series analysis. Simultaneous equation models would allow for the development of interindustry relationships and provide more insight into the complementary and substitutability relationships of labor employment among the alternative industries.

APPENDIX A
SPECIFICATION OF AREA ADJUSTMENT MODEL

In this model the product demands and factor supplies of all but the n^{th} factor are assumed to be perfectly elastic for a region in which k different types of industries exist.

A. Product Demands

$$(1) \quad P_{jk} = k_{jk} \quad j = 1, 2, \dots, m$$

B. Product Supplies

$$(2) \quad Q_{jk} = N_k q_{jk}(P, Z) \quad j = 1, 2, \dots, m$$

where

Q_{jk} = aggregate quantity of the j^{th} product supplied by firms in the k^{th} industry in the area.

N_k = number of firms in the k^{th} industry.

$q_{jk}(P, Z)$ = quantity of the j^{th} product supplied by a firm in the k^{th} industry as a function of the prices of all products and factors (p) and the exogenous shifters of product supply and factor demand functions (Z).

C. Factor Demands

$$(3) \quad Q_i = \sum_{k=1}^r N_k q_{ik}(P, Z) \quad i = m+1, m+2, \dots, n$$

where

Q_i = aggregate quantity of the i^{th} factor demanded in the area.

$q_{ik}(P, Z)$ = quantity of the i^{th} factor demanded by a firm in the k^{th} industry as a function of the prices for all products and factors (p) and the exogenous shifters of factor demand functions (Z).

D. Factor Supplies

$$(4) \quad P_i = k_i \quad i = m + 1, m + 2, \dots, n - 1$$

and for the n^{th} factor

$$(5) \quad Q_n = S_n(P, X) \quad p = m + 1, m + 2, \dots, n$$

where

Q_n = aggregate quantity of the n^{th} factor supplied in the area.

$S_n(P, X)$ = aggregate supply of the n^{th} factor as a function of all factor prices (P) and the exogenous shifters in the factor supply function (X).

E. Firm Entrepreneur Supply

$$(6) \quad N_k = \beta_k(\Pi_e, W) \quad e = 1, 2, \dots, r$$

where

$\beta_k(\Pi_e, W)$ = number of firm entrepreneurs willing to operate a firm in the k^{th} industry as a function of the residual returns from all types of industries (Π_e) and the exogenous shifters of firm entrepreneur supply (W). Additional comments on this function are given in the discussion of the total differential of this equation.

F. Industry Entrepreneur Residual Return Function

$$(7) \quad \Pi_k = N_k \sum_{j=1}^m q_{jk} P_j - N_k \sum_{i=m+1}^n q_{ik} P_i$$

where

Π_k = total residual return to all firms in the k^{th} industry.

q_{jk} = quantity of the j^{th} product produced by a firm in the k^{th} industry

P_j = price of the j^{th} product.

q_{ik} = quantity of i^{th} factor used by a firm in the k^{th} industry.

P_i = price of i^{th} factor.

Area adjustments imply various types of changes. Conversion of the above equations into their total differential form allows for a more thorough study of the nature of equilibration.

A. Product Demands

All area product demand functions are assumed to be perfectly elastic and all product price changes exogenous.

$$(1a) \quad dP_j = dk_j \quad \begin{array}{l} dk_j \text{ autonomous for } j = 1, 2, \\ \dots, m \end{array}$$

B. Product Supplies

$$(2a) \quad dQ_{jk} = \sum_{j=1}^m N_k \frac{\partial q_{jk}}{\partial P_j} + \sum_{i=m+1}^n N_k \frac{\partial q_{jk}}{\partial P_i} dP_i + \sum_{h=1}^v N_k \frac{\partial q_{jk}}{\partial Z_h} dZ_h + q_{jk} dN_k$$

C. Factor Demands

$$(3a) \quad dQ_i = \sum_{k=1}^r \sum_{j=1}^m N_k \frac{\partial q_{ik}}{\partial P_j} dP_j + \sum_{k=1}^r \sum_{i=m+1}^n N_k \frac{\partial q_{ik}}{\partial P_i} dP_i + \sum_{k=1}^r \sum_{h=1}^v N_k \frac{\partial q_{ik}}{\partial Z_h} dZ_h + \sum_{k=1}^r q_{ik} dN_k$$

Expanding the second term of (3a) and rewriting the equation in terms of the n^{th} factor gives

$$\begin{aligned}
 (3b) \quad dQ_n = & \sum_{k=1}^r \sum_{j=1}^m N_k \frac{\partial q_{nk}}{\partial P_j} dP_j + \sum_{k=1}^r \sum_{i=m+1}^{n-1} N_k \frac{\partial q_{nk}}{\partial P_i} dP_i \\
 & + \sum_{k=1}^r N_k \frac{\partial q_{nk}}{\partial P_n} dP_n + \sum_{k=1}^r \sum_{h=1}^v N_k \frac{\partial q_{nk}}{\partial Z_h} dZ_h \\
 & + \sum_{k=1}^r q_{nk} dN_k
 \end{aligned}$$

D. Factor Supplies

All area factor supply functions are assumed to be perfectly elastic except for the n^{th} factor, thus

$$(4a) \quad dP_i = dk_i \quad \begin{array}{l} dk_i \text{ autonomous for } i = m+1, \\ m+2, \dots, n-1 \end{array}$$

and for the n^{th} factor

$$(5a) \quad dQ_n = \sum_{i=m+1}^{n-1} \frac{\partial S_n}{\partial P_i} dP_i + \frac{\partial S_n}{\partial P_n} dP_n + \sum_{f=1}^t \frac{\partial S_n}{\partial X_f} dX_f$$

E. Firm Entrepreneur Supply

$$(6a) \quad dN_k = \sum_{e=1}^r \frac{\partial \beta_k}{\partial \pi_e} d\pi_e + \sum_{d=1}^s \frac{\partial \beta_k}{\partial W_d} dW_d$$

Interpretation of the first term in equation (6a) implies that a change in the number of firms in an industry is a function of the residual return to firm entrepreneurs in all industries. Since most major industries produce quite diverse products this is probably not true for most industries. In these situations this term would be zero with only the residual return in the k^{th} industry of interest influencing changes in the number of firms in that industry. To avoid misinterpretation of terms in later equations this term is left in general form as presented.

Since $N_k = \beta_k$ equation (6a) can be written as

$$(6b) \quad dN_k = \sum_{e=1}^r \frac{\partial N_k}{\partial \pi_e} d\pi_e + \sum_{d=1}^s \frac{\partial N_k}{\partial W_d} dW_d$$

F. Industry Entrepreneur Residual Return Function

$$(7a) \quad d\pi_k = \sum_{j=1}^m N_{kj} q_{jk} dP_j - \sum_{i=m+1}^n N_{ki} q_{ik} dP_i \\ + \left\{ \sum_{a=1}^m \left[\sum_{j=1}^m P_j \frac{\partial q_{jk} N_k}{\partial P_a} - \sum_{i=m+1}^n P_i \frac{\partial q_{ik} N_k}{\partial P_a} \right] dP_a \right. \\ + \sum_{a=m+1}^n \left[\sum_{j=1}^m P_j \frac{\partial q_{jk} N_k}{\partial P_a} - \sum_{i=m+1}^n P_i \frac{\partial q_{ik} N_k}{\partial P_a} \right] dP_a \left. \right\} \\ + \sum_{h=1}^v \left[\sum_{j=1}^m P_j \frac{\partial q_{jk} N_k}{\partial Z_h} - \sum_{i=m+1}^n P_i \frac{\partial q_{ik} N_k}{\partial Z_h} \right] dZ_h$$

Using the assumption that firms act as profit maximizers in a competitive market, the third term (enclosed in braces) in equation (7a) equals zero. This assumption means that the value of quantity changes of commodities produced induced by a small price change equals the value of quantity changes in factor utilization caused by the price change at an equilibrium position of the firm. This relationship follows from the discussion by Hicks [52, p. 322] of the stability conditions of production.

By letting

$\partial R_k = P_1 \partial q_{1k} N_{1k} + P_2 \partial q_{2k} N_{2k} + \dots + P_m \partial q_{mk} N_{mk} =$ change in total returns in the k^{th} industry and

$\partial C_k = P_{m+1} \partial q_{m+1,k} N_{m+1,k} + P_{m+2} \partial q_{m+2,k} N_{m+2,k} + \dots + P_n \partial q_{nk} N_{mk} =$ change in total costs in the k^{th} industry, then equation (7a)

can be written as

$$\begin{aligned}
 (7b) \quad d\pi_k = & \sum_{j=1}^m N_k q_{jk} dP_j - \sum_{i=m+1}^{n-1} N_k q_{ik} dP_i - N_k q_{nk} dP_n \\
 & + \sum_{h=1}^v \left[\frac{\partial R_k}{\partial Z_h} - \frac{\partial C_k}{\partial Z_h} \right] dZ_h
 \end{aligned}$$

Differential equations (1a), (2a), (3b), and (5a) indicate the changes in the quantity of products and factors supplied and demanded resulting from changes in prices, exogenous shifters, and the number of firms in a given industry. Equilibrium conditions would imply that changes in the quantity demanded and supplied of any factor or product were always equal. Since all product and factor prices except for the n^{th} factor are considered to be exogenously determined in this model, the equilibration process centers on the demand and supply of the n^{th} factor. Changes in product and factor prices and exogenous shifters of firm supply also can alter the residual return received by firm entrepreneurs. Equations (6b) and (7b) bring the functions related to the number of firms in an industry into the equilibration process. The equilibration process that will ultimately lead to an equation explaining changes in employment as a function of product and factor prices, shifters of firm production possibilities, shifters of factor supply, and changes in the numbers of firms is described below. Also derived is an equation explaining changes in firm numbers as a function of product and factor prices, shifters of firm production possibilities, shifters of factor supply, and shifters of firm entrepreneur supply.

Equating total differentials for the n^{th} factor demand (3b) and factor supply (5a) and solving for dP_n gives

$$(8) \quad dP_n = f(dP_j, dP_i, dZ_h, dX_f, dN_k).$$

$$j = 1, 2, \dots, m$$

$$i = m + 1, m + 2, \dots, n - 1$$

$$h = 1, 2, \dots, v$$

$$f = 1, 2, \dots, t$$

$$k = 1, 2, \dots, r$$

Equation (3a) expresses the total change in the quantity of the i^{th} factor demanded in the area. This equation can be written in terms of labor demanded as

$$\begin{aligned} (9) \quad dQ_L = & \sum_{k=1}^r \sum_{j=1}^m N_k \frac{\partial q_{Lk}}{\partial P_j} dP_j + \sum_{k=1}^r \sum_{i=m+1}^{n-1} N_k \frac{\partial q_{Lk}}{\partial P_i} dP_i \\ & + \sum_{k=1}^r N_k \frac{\partial q_{Lk}}{\partial P_n} dP_n + \sum_{k=1}^r \sum_{h=1}^v N_k \frac{\partial q_{Lk}}{\partial Z_h} dZ_h + \sum_{k=1}^r q_{Lk} dN_k \end{aligned}$$

Substitution of equation (8) into (9) gives an equation of the form

$$(10) \quad dQ_L = f(dX_f, dP_j, dP_i, dZ_h, dN_k)$$

$$f = 1, 2, \dots, t$$

$$j = 1, 2, \dots, m$$

$$i = m + 1, m + 2, \dots, n - 1$$

$$h = 1, 2, \dots, v$$

$$k = 1, 2, \dots, r$$

which expresses the total change in the quantity of labor demanded in the area as a function of exogenous changes in shifters of factor supplies, product prices, factor prices except for the n^{th} factor, shifters of firm production possibilities, and the number of firms. Finally, equation (10) can be written for the k^{th} industry as

$$\begin{aligned}
 (11) \quad dQ_{Lk} = & \sum_{f=1}^t \left[b_{Lkn} \left(\frac{1}{A} \right) s_f \right] dX_f \\
 & + \sum_{j=1}^m \left[d_{Lkj} - b_{Lkn} \left(\frac{1}{A} \right) d_{nkj} \right] dP_j \\
 & + \sum_{i=m+1}^{n-1} \left[d_{Lki} - b_{Lkn} \left(\frac{1}{A} \right) d_{nki} \right] dP_i \\
 & + \sum_{h=1}^v \left[d_{Lkh} - b_{Lkn} \left(\frac{1}{A} \right) d_{nkh} \right] dZ_h \\
 & + \left[q_{Lk}^0 - b_{Lkn} \left(\frac{1}{A} \right) q_{nk}^0 \right] dN_k
 \end{aligned}$$

The definition and interpretation of each term is given in Table 15. This equation is similar to that discussed by Eddleman [20] except that equation (11) is expressed in terms of absolute changes and each coefficient contains terms consisting of partial derivatives. Eddleman's equation was expressed in terms of elasticities and percent changes.

Bringing the industry firm supply function into the equilibration process by substituting (6b) into (8) gives

$$(12) \quad dP_n = f(dP_j, dP_i, dZ_h, dX_f, d\pi_e, dW_d)$$

$$j = 1, 2, \dots, m$$

$$i = m + 1, m + 2, \dots, n - 1$$

$$h = 1, 2, \dots, v$$

$$f = 1, 2, \dots, t$$

$$e = 1, 2, \dots, r$$

$$d = 1, 2, \dots, s$$

Table 15. Definition and interpretation of terms in equation (11)^a

Term	Definition	Interpretation
b_{Lkn}	$N_k^0 \frac{\partial q_{Lk}}{\partial P_n}$	Change in quantity of labor demanded in the k^{th} industry associated with a one unit change in price of the n^{th} factor.
d_{Lkj}	$N_k^0 \frac{\partial q_{Lk}}{\partial P_j}$	Change in quantity of labor demanded in the k^{th} industry associated with a one unit change in price of the j^{th} product.
d_{Lki}	$N_k^0 \frac{\partial q_{Lk}}{\partial P_i}$	Change in quantity of labor demanded in the k^{th} industry associated with a one unit change in price of the i^{th} factor.
d_{Lkh}	$N_k^0 \frac{\partial q_{Lk}}{\partial Z_h}$	Change in quantity of labor demanded in the k^{th} industry associated with a one unit change in price of the h^{th} shifter of firm production possibilities.
q_{Lk}	q_{Lk}^0	Quantity of labor demanded by a firm in the k^{th} industry.
A	$\sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_n} - \frac{\partial S_n}{\partial P_n}$	Difference in total quantity of the n^{th} factor demanded and supplied associated with a one unit change in price of the n^{th} factor.
S_f	$\frac{\partial S_n}{\partial X_f}$	Change in total quantity supplied of the n^{th} factor associated with a one unit change in the f^{th} shifter of factor supplies.
d_{nkj}	$N_k^0 \frac{\partial q_{nk}}{\partial P_j}$	Change in quantity of the n^{th} factor demanded in the k^{th} industry associated with a one unit change in price of the j^{th} product.
d_{nki}	$\frac{\partial S_n}{\partial P_i} - \sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_i}$	Difference in total quantity of the n^{th} factor supplied and demanded associated with a one unit change in price of the i^{th} factor.

Table 15 (Continued)

Term	Definition	Interpretation
d_{nkh}	$N_k^0 \frac{\partial q_{nk}}{\partial z_h}$	Change in quantity of the n^{th} factor demanded in the k^{th} industry associated with a one unit change in the h^{th} shifter of firm production possibilities.
q_{nk}^0	q_{nk}^0	Quantity of the n^{th} factor demanded for a firm in the k^{th} industry.

^aThe superscript 0 indicates initial values.

Letting $d\pi_e = d\pi_k$ for the k^{th} industry and substituting the industry return function (7b) into (12) gives the total price change of the n^{th} factor as a function of all exogenous variables as expressed by

$$(13) \quad dP_n = f(dP_j, dP_i, dZ_h, dX_f, dW_d)$$

$$j = 1, 2, \dots, m$$

$$i = m + 1, m + 2, \dots, n - 1$$

$$h = 1, 2, \dots, v$$

$$f = 1, 2, \dots, t$$

$$d = 1, 2, \dots, s.$$

Then, by substitution of (13) into (7b) we get

$$(14) \quad d\pi_k^1 = f(dP_j, dP_i, dZ_h, dX_f, dW_d)$$

$$j = 1, 2, \dots, m$$

$$i = m + 1, m + 2, \dots, n - 1$$

$$h = 1, 2, \dots, v$$

$$f = 1, 2, \dots, t$$

$$d = 1, 2, \dots, s.$$

Finally by letting $d\pi_k = d\pi_e$ for the k^{th} industry and substituting (14) into (6b) we can derive an equation which expresses the change in the number of firms in the k^{th} industry as a function of all exogenous variables. This equation may conveniently be written as

$$(15) \quad dN_k = - \sum_{f=1}^t \left[a_{kn} \left(\frac{1}{B} \right) S_f \right] dX_f \\ + \sum_{d=1}^s \left[\lambda_{kd} + a_{kn} \left(\frac{1}{B} \right) D_d \right] dW_d \\ + \sum_{j=1}^m \left[a_{kj} + a_{kn} \left(\frac{1}{B} \right) U_j \right] dP_j$$

$$\begin{aligned}
& - \sum_{i=m+1}^{n-1} \left[a_{ki} - a_{kn} \left(\frac{1}{B} \right) L_i \right] dP_i \\
& + \sum_{h=1}^v \left[c_{kh} + a_{kn} \left(\frac{1}{B} \right) M_h \right] dZ_h
\end{aligned}$$

The definition and interpretation of each term is given in Table 16.

Several of the terms found in equation (15) require interpretive discussion. These terms are a_{kn} , a_{kj} , a_{ki} , and c_{kh} . Complete interpretation of a_{kn} is given in the following discussion. The similarity of the remaining terms to a_{kn} will then become apparent.

The term, $a_{kn} = \sum_{e=1}^r \frac{\partial N_k}{\partial \pi_e} q_{ne} N_e$, is defined as the change in the number of firms associated with a change in entrepreneurial residual return brought about by a one unit change in price of the n^{th} factor. This definition is not readily apparent from the mathematical terms involved. Change in entrepreneurial residual return in the e^{th} industry can be defined as

$$\begin{aligned}
\Delta \pi_e = N_e & \sum_{j=1}^m P_j^* q_{je} - \sum_{i=m+1}^n P_i^* q_{ie} - N_e \sum_{j=1}^m P_j q_{je} \\
& - \sum_{i=m+1}^n P_i q_{ie}
\end{aligned}$$

where

$$P_j^* = P_j \quad j = 1, 2, \dots, m$$

$$P_i^* = P_i \quad i = m+1, m+2, \dots, n-1$$

$$P_n^* = P_n + \Delta P_n$$

$$q_{je}^* = q_{je}^0 + \Delta q_{je} \quad j = 1, 2, \dots, m$$

Table 16. Definition and interpretation of terms in equation (12)^a

Term	Definition	Interpretation
a_{kn}	$\sum_{e=1}^r \frac{\partial N_k}{\partial \Pi_e} q_{ne}^o N_e^o = \sum_{e=1}^r \frac{\partial N_k}{\partial P_n}$	Change in the number of firms in the k^{th} industry associated with a change in entrepreneurial residual return brought about by a one unit change in price of the n^{th} factor. ^b
λ_{kd}	$\frac{\partial N_k}{\partial W_d}$	Change in the number of firms in the k^{th} industry associated with a one unit change in the d^{th} shifter of firm entrepreneur supply.
a_{kj}	$\sum_{e=1}^r \frac{\partial N_k}{\partial \Pi_e} q_{je}^o N_e^o = \sum_{e=1}^r \frac{\partial N_k}{\partial P_j}$	Change in the number of firms in the k^{th} industry associated with a change in entrepreneurial residual return brought about by a one unit change in price of the j^{th} product. ^b
a_{ki}	$\sum_{e=1}^r \frac{\partial N_k}{\partial \Pi_e} q_{ie}^o N_e^o = \sum_{e=1}^r \frac{\partial N_k}{\partial P_i}$	Change in the number of firms in the k^{th} industry associated with a change in entrepreneurial residual return brought about by a one unit change in price of the k^{th} factor. ^b
c_{kh}	$\sum_{e=1}^r \frac{\partial N_k}{\partial \Pi_e} \left[\frac{\partial R_e}{\partial Z_h} - \frac{\partial C_e}{\partial Z_h} \right]$	Change in the number of firms in the k^{th} industry associated with a change in entrepreneurial residual return brought about by a one unit change in firm production possibilities. ^b
B	$\left[\sum_{k=1}^r N_k^o \frac{\partial q_{nk}}{\partial P_n} - \frac{\partial S_n}{\partial P_n} \right] - \sum_{k=1}^r q_{nk}^o a_{kn}$	Excess demand for the n^{th} factor associated with a one unit change in price of the n^{th} factor.

Table 16 (Continued)

Term	Definition	Interpretation
S_f	$\frac{\partial S_n}{\partial X_f}$	Change in total quantity supplied of the n^{th} factor associated with a one unit change in the f^{th} shifter of factor supplies.
D_d	$\sum_{k=1}^r q_{nk}^0 \lambda_{kd}$	Change in total demand for the n^{th} factor associated with a one unit change in the d^{th} shifter of firm entrepreneur supply.
U_j	$\sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_j} + \sum_{k=1}^r q_{nk}^0 a_{kj}$	Change in total demand for the n^{th} factor associated with a one unit change in price of the j^{th} product.
L_i	$\left[\frac{\partial S_n}{\partial P_i} - \sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial P_i} \right] + \sum_{k=1}^r q_{nk}^0 a_{ki}$	Difference in total quantity of the n^{th} factor that would be demanded and supplied associated with a one unit change in price of the i^{th} factor.
M_h	$\sum_{k=1}^r N_k^0 \frac{\partial q_{nk}}{\partial Z_h} + \sum_{k=1}^r q_{nk}^0 c_{kh}$	Change in total demand for the n^{th} factor associated with a one unit change in the h^{th} shifter of firm production possibilities.

^aThe superscript o indicates initial value.

^bSee Table 19 and following discussion.

$$q_{ie}^* = q_{ie}^0 + \Delta q_{ie} \quad i = m + 1, m + 2, \dots, n - 1$$

Δq_{je} = change in q_{je} resulting from ΔP_n

Δq_{ie} = change in q_{ie} resulting from ΔP_n

N_e = number of firms in the e^{th} industry.

Making the above substitutions and rearranging terms gives

$$\Delta \Pi_e = \Delta P_n q_{ne}^0 N_e + \Delta P_n \Delta q_{ne} N_e + \left[\sum_{j=1}^m P_j \Delta q_{je} - \sum_{i=m+1}^n P_i \Delta q_{ie} \right] N_e.$$

Assuming that the bracketed term is close to zero based on Hick's stability condition of production discussed earlier in the appendix, and assuming that Δq_{ne} is small relative to q_{ne}^0 , the term reduces to

$$\Delta \Pi_e \approx - \Delta P_n q_{ne}^0 N_e$$

Since $a_{kn} = \frac{\partial N_k}{\partial \Pi_e} q_{ne}^0 N_e^0$, appropriate substitution would allow a_{kn} to be

written as $\frac{\partial N_k}{\partial P_n}$ and interpreted as the change in the number of firms as-

sociated with a one unit change in P_n operating through a reduction in entrepreneurial residual return.

Similar substitutions could be performed for the terms a_{kj} , a_{ki} , and c_{kh} . Table 17 summarizes the appropriate approximation for $\Delta \Pi_e$ for each term.

Equation (15) is similar to that used by Schrimper [18] with two exceptions. Schrimper's model was concerned with the rate of change expressed as percentages and had elasticities incorporated into the

Table 17. Approximation of terms to represent a change in residual return

Term	Definition	Representation for $\Delta\Pi_e$
a_{kn}	$\frac{\partial N_k}{\partial \Pi_e} q_{ne}^o N_e^o$	$\approx -\Delta P_n^o q_{ne}^o N_e^o$
a_{kj}	$\frac{\partial N_k}{\partial \Pi_e} q_{je}^o N_e^o$	$\approx \Delta P_j^o q_{je}^o N_e^o$
a_{ki}	$\frac{\partial N_k}{\partial \Pi_e} q_{ie}^o N_e^o$	$\approx -\Delta P_i^o q_{ie}^o N_e^o$
c_{kh}	$\frac{\partial N_k}{\partial \Pi_e} \left[\frac{\partial R_e}{\partial Z_h} - \frac{\partial C_e}{\partial Z_h} \right]$	$\approx \Delta\Pi_e \left[\frac{R_e}{Z_h} - \frac{C_e}{Z_h} \right]^a$

^aThis effect would occur through either an output increasing and/or input decreasing change in firm production possibilities. Since both could occur the representation is written in a similar manner to the actual definition.

coefficients whereas equation (15) is expressed in terms of absolute changes and each coefficient consists of combinations of partial derivatives as shown in Table 16. A complete discussion of the similar equation and its terms can be found in Schrimper [18, pp. 116-133].

APPENDIX B

MEANS AND STANDARD DEVIATIONS OF VARIABLES

Table 18. Means and standard deviations of employment change variables for each county group of observations^a

County group	E ₁	E ₂	E ₃	E ₄	E ₅	E ₆	E ₇	E _D	E _{ND}
All counties									
Mean	-553.1	273.0	197.9	-41.3	224.8	-48.1	141.6	374.6	180.4
Standard deviation	696.2	943.8	725.5	252.4	688.9	183.3	507.6	1,207.8	708.7
Urban counties									
Mean	-272.0	804.2	209.7	-191.7	603.8	-55.5	370.4	1,059.5	86.6
Standard deviation	695.1	1,809.1	1,358.1	437.1	1,277.7	277.1	889.9	2,254.9	1,288.4
Nonurban counties									
Mean	-642.5	104.1	194.1	7.6	98.5	-45.7	50.5	154.5	210.4
Standard deviation	673.5	153.6	337.2	114.6	171.5	141.6	135.3	327.9	365.5

^a Industry identification given in Chapter III, Table 1.

Table 19. Means and standard deviations of firm number change variables for each county group of observations^a

County group	N ₁	N ₃	N ₄	N ₅	N ₆	N ₇	N _D	N _{ND}
All counties								
Mean	-422.96	1.41	-1.17	.96	4.03	.70	7.35	.60
Standard deviation	367.07	6.29	7.21	4.66	10.88	3.13	20.33	11.21
Urban counties								
Mean	-373.77	2.42	-3.56	2.94	4.06	2.06	14.20	.17
Standard deviation	377.48	11.73	13.92	8.90	14.27	5.56	36.63	21.97
Nonurban counties								
Mean	-438.60	1.08	-.39	.30	4.02	.16	5.14	.74
Standard deviation	362.30	2.72	1.84	.92	9.55	.60	9.75	3.41

^a Industry identification given in Chapter 111, Table 1.

Table 20. Means and standard deviations of factor supply variables for each county group of observations

County group ^a	x_1^b	x_2^b	x_3^b	x_4^b	x_5^b	x_6^b
	-----dollars-----	-----thousand dollars-----	-----thousand dollars-----	-----thousand dollars-----	-----thousand dollars-----	-----acres-----
All counties						
Mean	290.5	1,813.9	93.6	651.2	644.2	-64.1
Standard deviation	90.3	6,013.2	226.9	372.7	896.2	317.2
Urban counties						
Mean	334.8	3,196.8	99.5	602.3	814.4	-43.4
Standard deviation	103.0	6,364.7	275.7	397.8	1,131.2	192.9
Nonurban counties						
Mean	276.4	1,374.1	91.8	666.7	590.0	-70.6
Standard deviation	80.9	5,828.6	209.0	363.0	799.7	347.3

^aFor the total number of counties in each group. Means and standard deviations are not shown for each equation since the changes were extremely small. Counties left out of individual industry equations since no employment was reported did not alter the means enough to warrant reporting them. These reported for all counties give sufficient indication of their relative magnitudes.

^bFactor supply categories defined in Chapter III.

Table 21. Means and standard deviations of product price change variables for each county group of observations^a

County group	PP ₁	PP ₃	PP ₄	PP ₆	PP _D	PP _{ND}
All counties						
Mean	8.55	11.27	24.29	28.52	23.19	16.54
Standard deviation	7.45	7.92	3.67	4.30	7.62	7.96
Urban counties						
Mean	12.52	11.31	24.52	26.44	16.54	18.30
Standard deviation	8.02	5.20	3.80	4.36	7.05	6.16
Nonurban counties						
Mean	7.29	11.26	24.22	29.18	25.32	15.98
Standard deviation	6.78	8.62	3.62	4.06	6.48	8.38

^a Industry identification given in Chapter III, Table 1.

Table 22. Means and standard deviations of wage change variables for each county group of observations^a

County group	FP ₁	FP ₂	FP ₃	FP ₄	FP ₅	FP ₆	FP ₇	FP _D	FP _{ND}
All counties									
Mean	884.0	2,035.5	2,151.4	2,192.4	2,223.7	2,227.5	2,763.1	2,254.8	2,194.1
Standard deviation	2,448.0	1,371.7	950.3	1,009.7	925.7	1,088.9	6,120.0	987.3	958.6
Urban counties									
Mean	721.9	2,539.0	2,494.2	2,398.4	2,589.7	2,621.6	4,274.5	2,730.4	2,537.8
Standard deviation	1,570.3	1,288.4	1,147.2	1,154.8	1,073.5	1,387.3	11,252.0	1,154.9	1,130.3
Nonurban counties									
Mean	935.6	1,875.4	2,040.0	2,125.4	2,101.7	2,102.2	2,161.3	2,101.9	2,084.4
Standard deviation	2,665.1	1,358.6	847.5	948.3	835.9	941.0	828.7	873.7	868.8

^aIndustry identification given in Chapter III, Table 1.

Table 23. Means and standard deviations for technology change variables for each county group of observations^a

County group	Z ₁	Z ₃	Z ₄	Z ₅	Z ₆	Z ₇	Z _D	Z _{ND}
All counties								
Mean	92.24	13.06	36.96	17.94	26.30	7.31	25.22	28.66
Standard deviation	19.76	20.20	6.91	3.30	10.45	6.08	10.77	19.69
Urban counties								
Mean	89.53	10.01	36.12	17.72	23.83	8.60	24.08	34.78
Standard deviation	28.51	16.55	5.05	4.77	10.68	7.88	12.68	12.71
Nonurban counties								
Mean	93.10	14.05	37.24	18.01	27.09	6.80	25.59	26.70
Standard deviation	15.91	21.16	7.40	2.63	10.25	5.11	10.07	21.08

^a Industry identification given in Chapter III, Table 1.

Table 24. Means and standard deviations for wage opportunity change variables for each county group of observations^a

County group	WM ₁	WM ₂	WM ₃	WM ₄	WM ₅	WM ₆	WM ₇	WM _D	WM _{ND}
All counties									
Mean	3.14	8.15	2.58	2.68	2.35	2.84	2.09	2.83	2.83
Standard deviation	3.85	11.69	3.43	4.81	2.64	5.21	2.50	5.22	5.21
Urban counties									
Mean	3.56	3.11	1.70	1.71	1.48	1.70	1.58	1.70	1.70
Standard deviation	5.57	4.89	2.71	2.72	2.24	2.71	2.66	2.71	2.72
Urban counties									
Mean	3.01	9.75	2.86	2.99	2.64	3.20	2.29	3.20	3.20
Standard deviation	3.10	12.72	3.59	5.28	2.70	5.73	2.40	5.75	5.74

^aManufacturing wage opportunity means varied substantially in some cases in the different industry equations as a result of the omission of counties due to no employment in the particular industry. For these reasons the individual variable means are reported for each industry. Industry identification given in Chapter III, Table 1.

Table 25. Means and standard deviations for employment opportunity change variables for each county group of observations^a

County group	WE ₁	WE ₂	WE ₃	WE ₄	WE ₅	WE ₆	WE ₇	WE _D	WE _{ND}	WA
All counties										
Mean	6.68	6.93	68.51	39.65	170.41	26.83	216.05	9.26	10.86	-110.25
Standard deviation	9.28	3.72	233.75	51.19	253.76	77.75	312.83	14.18	20.32	127.23
Urban counties										
Mean	11.37	5.79	187.49	30.19	178.48	64.65	256.2	15.63	13.88	-123.13
Standard deviation	16.77	3.55	388.95	34.49	253.89	145.95	344.8	23.26	20.97	140.49
Nonurban counties										
Mean	2.55	7.30	29.85	42.72	167.71	14.80	200.07	7.22	9.89	-106.15
Standard deviation	2.31	3.70	130.95	55.20	253.65	24.33	297.65	8.64	20.01	122.43

^a Industry identification given in Chapter III, Table 1.

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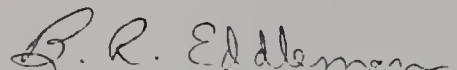
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BIOGRAPHICAL SKETCH

James C. Cato was born in Vernon, Texas, on October 28, 1942, the son of Willis E. and Mildred Cato. He graduated from Lockett High School, Vernon, Texas, in 1961. In June, 1967, he received the Bachelor of Science degree in agricultural economics at Texas Tech University, Lubbock, Texas. A Master of Science degree in agricultural economics was received from Texas Tech University in June, 1968. He served as an instructor in agricultural economics at Texas Tech University in 1968 and early 1969. He enrolled in the Graduate School of the University of Florida in 1969. He was employed by the Economic Research Service, United States Department of Agriculture from 1969 until 1973. Since June, 1973, he has been employed as Graduate Research Associate and Extension Marine Economist with the Department of Food and Resource Economics, University of Florida, Gainesville, Florida.

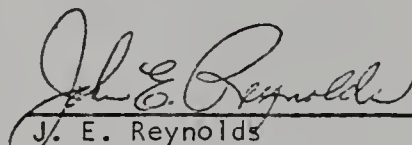
He married Diane Lynette Richardson, from Vernon, Texas, on December 28, 1965, and has two sons, Kyle and Chad. He is a member of Alpha Zeta, Gamma Sigma Delta, Omicron Delta Epsilon, American Agricultural Economics Association, Southern Agricultural Economics Association, and the American Economics Association.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



B. R. Eddleman, Chairman
Associate Professor of
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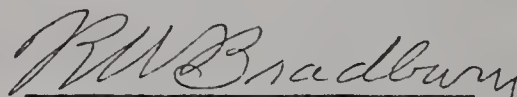
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Associate Professor of
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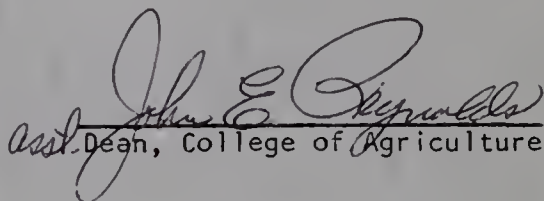
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This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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